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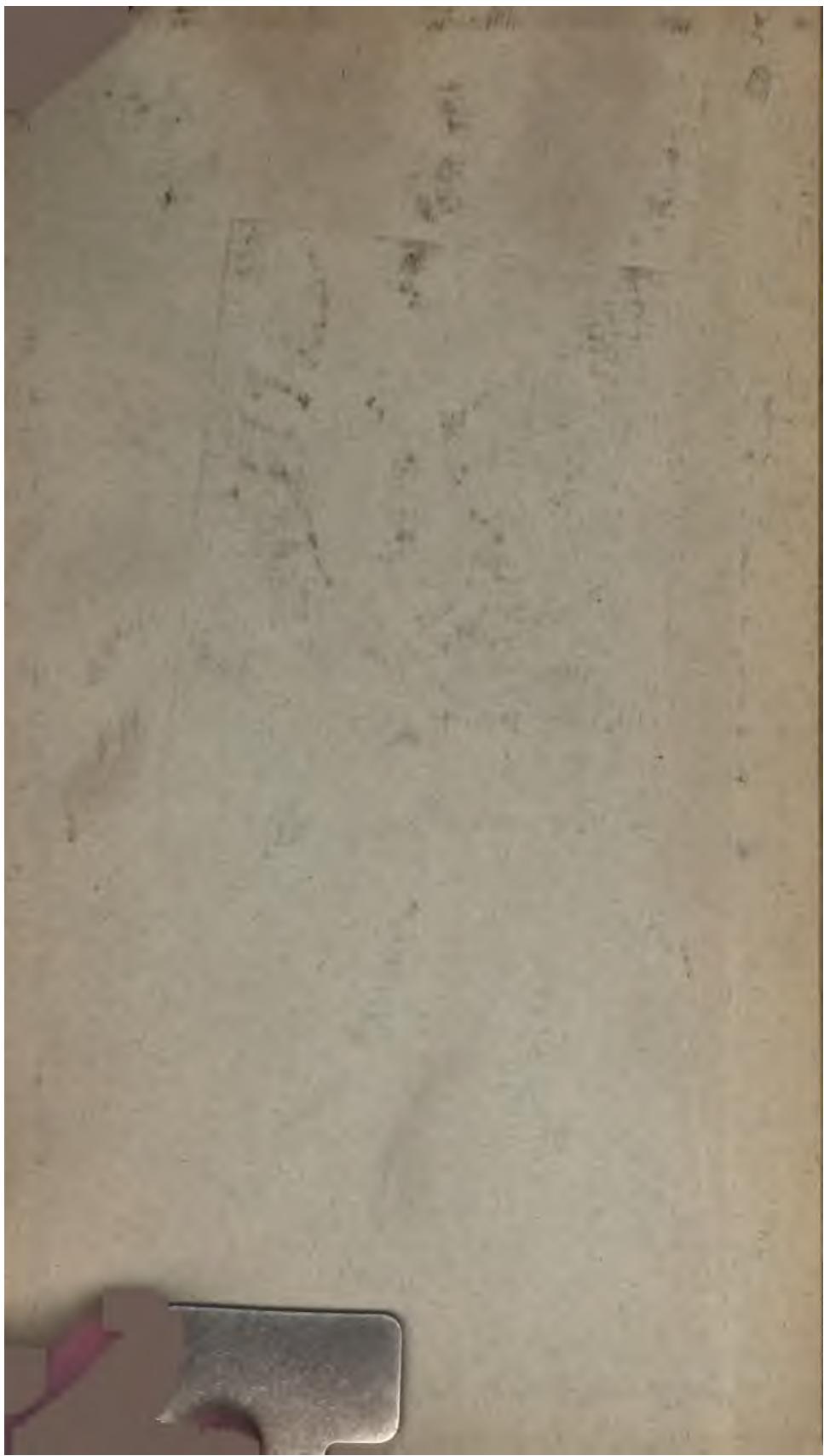
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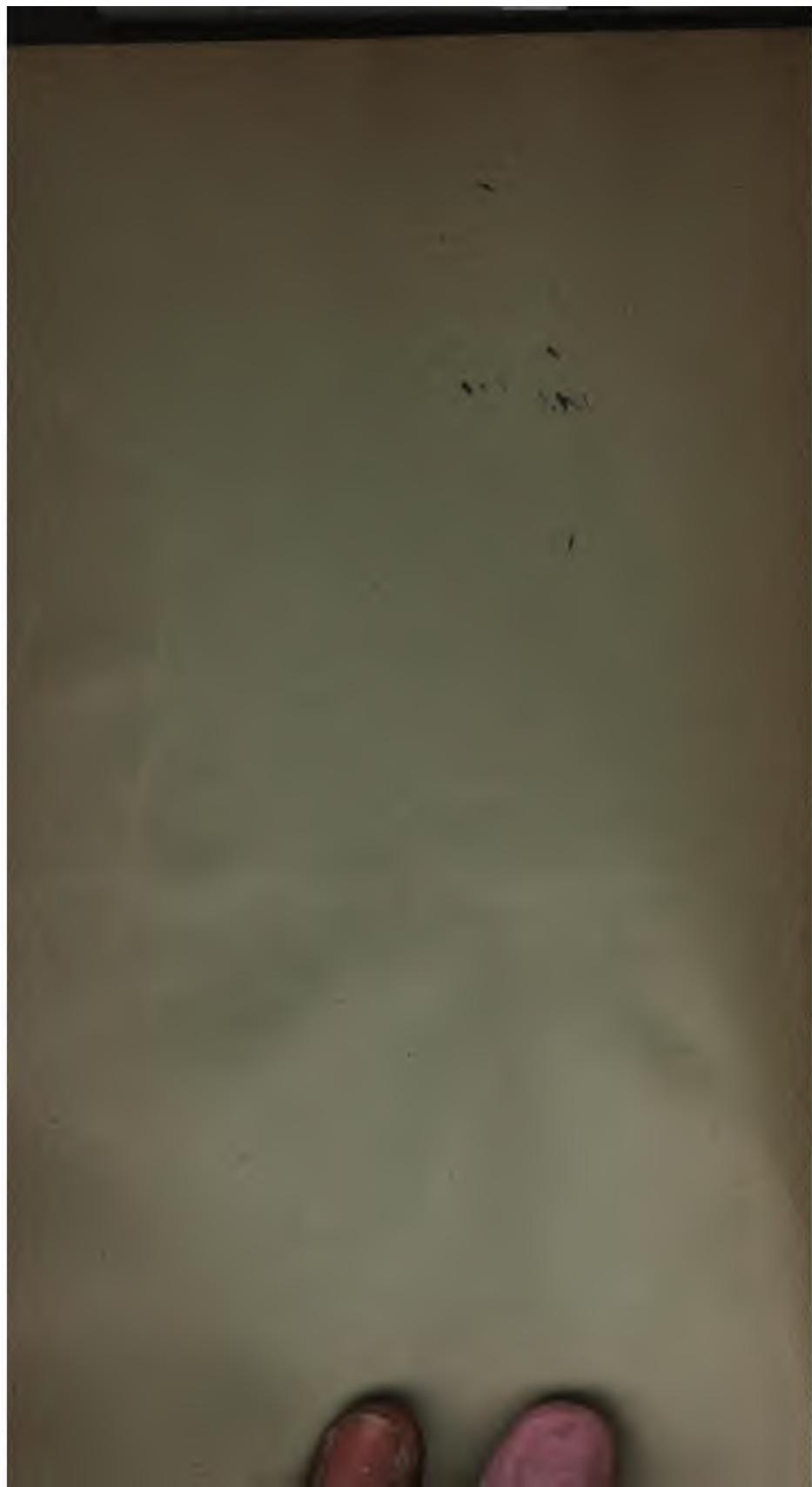
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CATALOGUE OF EARTHQUAKES

ON THE

PACIFIC COAST

1769 TO 1897

BY

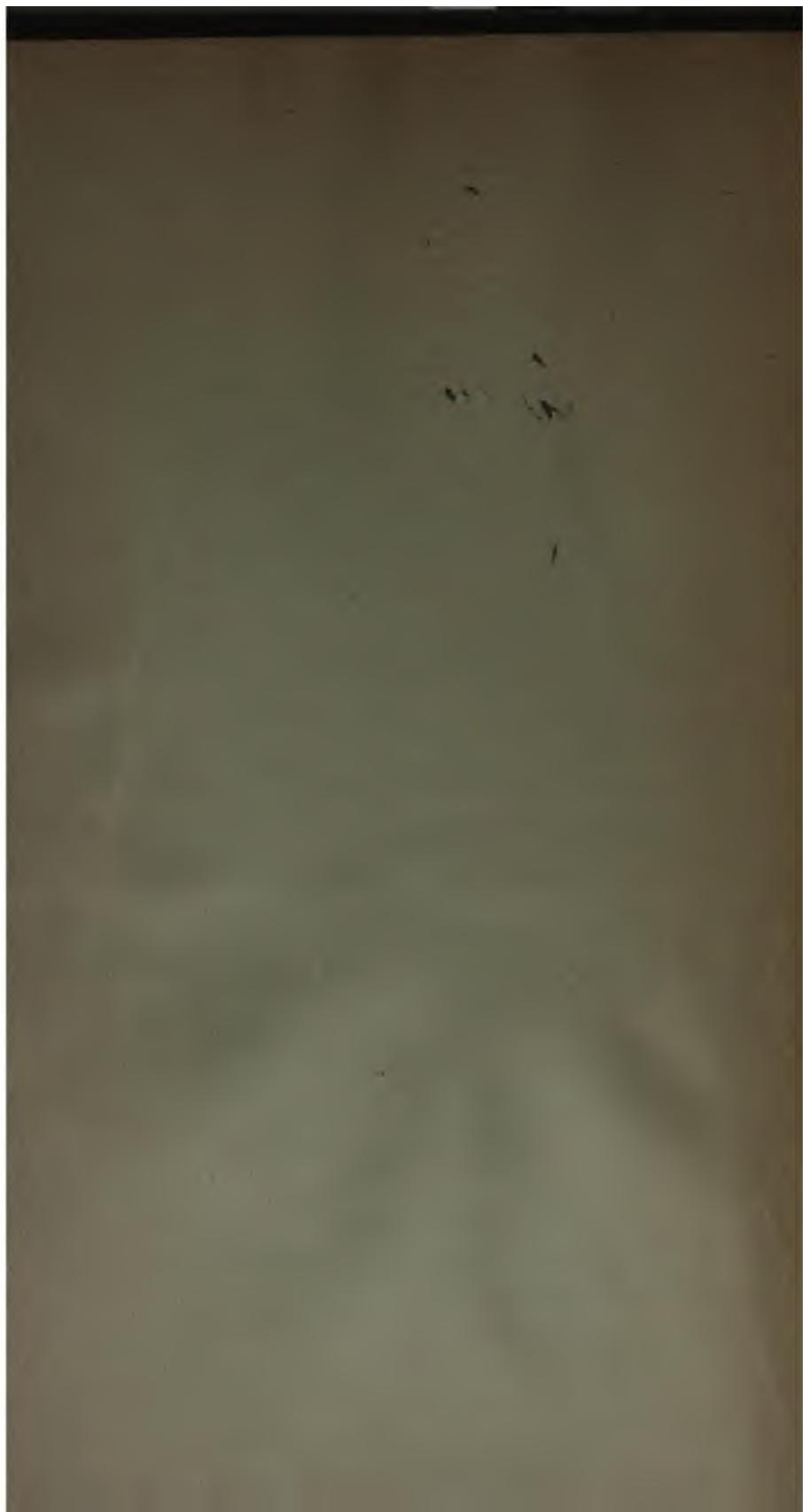
EDWARD S. HOLDEN, LL.D.

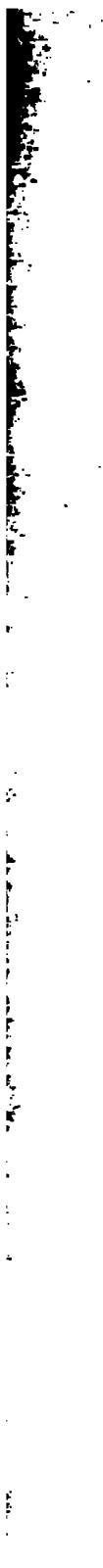
Member of the National Academy of Sciences



CITY OF WASHINGTON
PUBLISHED BY THE SMITHSONIAN INSTITUTION

1898





Earthquakes on Pacific Coast.—Holden.

PLAT



MAP OF CALIFORNIA AND NEVADA.

SMITHSONIAN MISCELLANEOUS COLLECTIONS

— 1087 —

A CATALOGUE OF EARTHQUAKES
ON THE
PACIFIC COAST

1769 TO 1897

BY

EDWARD S. HOLDEN, LL.D.
Member of the National Academy of Sciences



CITY OF WASHINGTON
★ PUBLISHED BY THE SMITHSONIAN INSTITUTION ★
1898
421
E. A. H.



The Lord Baltimore Press

THE FRIEDENWALD COMPANY

BALTIMORE, MD., U.S.A.



SMITHSONIAN INSTITUTION.

WASHINGTON CITY, January, 1898.

This work (No. 1087), "A CATALOGUE OF EARTHQUAKES ON THE PACIFIC COAST, 1769 to 1897," by Edward S. Holden, forms part of Smithsonian Miscellaneous Collections, Volume XXXVII.

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Holden, Edward S. Smithsonian Miscellaneous Collections, Vol. xxxvii. (Number 1087.)

A Catalogue of Earthquakes on the Pacific Coast, 1769 to 1897. By Edward S. Holden. City of Washington, published by the Smithsonian Institution, 1898. 8°. ii, 253 pp., with 5 plates and 5 text figures.

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WILLY WEA
DOLGAR
VIA RISU

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INTRODUCTION.

In the year 1887 the Regents of the University of California authorized the printing and distribution of an octavo pamphlet whose title was "List of Recorded Earthquakes in California, Lower California, Oregon and Washington Territory, compiled by . . . Edward S. Holden." This was the first systematic publication of the sort, and it served a useful purpose. The examination of past records naturally led to the consideration of the best manner of making future ones. The object of such records is to bring to light all the general facts as to distribution of earthquake shocks, as to topographic areas, as to time, as to average intensity, etc., and also to enable a study to be made of particular shocks—as to velocity of transit, area of the disturbed region, intensity, etc. In order to study any of these questions with profit it is necessary to have some kind of a measure of the intensity of each earthquake shock. The most satisfactory instruments that I have seen for this purpose are those invented by Professor Ewing, F. R. S. These are devised on sound mechanical principles, and are well constructed by the Cambridge Scientific Company. It was necessary at the Lick Observatory to keep a register of the times of occurrence of all earthquake shocks in order to see if the positions of the astronomical instruments were affected. Accordingly, a set of Professor Ewing's instruments was ordered for the Observatory, and they were delivered in 1887.

The Lick Observatory began its active work in 1888. A part of this work consisted in the registration of earthquake shocks. Reports of shocks felt elsewhere on the Pacific Coast were diligently collected, and the publication of the pamphlet before mentioned brought me into relations with various gentlemen who were kind enough to communicate MS. notes or diaries relating to earthquake phenomena in earlier years.

The present volume reprints the pamphlet of 1887, with many corrections and additions; and it gives a complete account of the earthquake observations at Mount Hamilton during the years 1887 to 1897, together with an abstract of the great amount of information which has been collected regarding Pacific Coast earthquakes in the latter period. All previously printed information has been thoroughly revised before its admission to these pages.

The chief sources drawn upon are—

First—Printed lists of earthquake shocks in the scientific journals; such as the lists of Mallet, Perrey, Rockwood, Fuchs, Trask and others.

Second—Accounts of earthquakes in printed books, magazines and newspapers.

Third—Lists of shocks put at my disposition by various gentlemen, especially a list by Mr. Thos. Tennent, of San Francisco; a list by Prof. H. G. Hanks; and a very extensive collection kindly furnished by Mr. H. H. Bancroft from manuscript records.

Fourth—Verbal accounts from various friends of the Observatory.

Fifth—The earthquake records of the University of California (Berkeley); the Chabot Observatory (Oakland); the University of the Pacific (San José); Mills Seminary (Oakland); the Weather Bureau (Carson, Nevada); and of the Lick Observatory (Mount Hamilton). All these stations are supplied with earthquake instruments.

I have to thank Professor Rockwood, of Princeton University, for putting me in the way of gaining much of the printed information. I have also to express my great obligations to the Board of Directors of the Mechanics' Institute Library, to the Council of the California Academy of Sciences, and to the Librarians of the Mechanics' Institute, Mercantile and Academy of Science libraries in San Francisco, the University of California Library at Berkeley, and of the State Library at Sacramento, for exceptional facilities afforded me in the consultation of books. Mr. W. C. Winlock, late of the Smithsonian Institution, kindly consulted, in the Library of Congress, books which were not available in California. The various sources of information have been thoroughly examined, and the necessary data for a brief reference list, or index, have been extracted and set in order in the catalogue which follows.

The list of books and periodicals consulted is given in the following:

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- Perrey (A.): *Notes sur les tremblements de terre en . . . 1850; Mém. de l'Acad. de Dijon, Année 1851. 1851; Ibid., 1852-53. 1853; Ibid., 1854. Les tremblements de terre, etc., de la Côte N. O. d'Amérique. Ibid., 1865.* [NOTE: It is likely that many of the "eruptions" of Oregon and California mountains, which are noted by Perrey, were due to forest fires, fog, cloud, etc.—E. S. H.]
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From the above sources of information the following catalogue has been derived.

For each shock there is given, when possible, *first*, the year, month and day; *second*, the hour, minute and second. The time is here given exactly as it is found in the original. Usually it is expressed in local civil time. In Dr. Trask's list it is intended to be astronomical time (0h. is noon, and 12h. midnight), though there are probably several errors in this datum. For the later lists it is usually Pacific standard (railway) time.* In Mr. Tennent's observations it is San Francisco local mean time to and including March 25, 1884, and after that date Pacific standard time. Professor Rockwood's plan to avoid the danger of confounding A. M. and P. M. dates, is to adopt the system of numbering the hours in the civil day from 0 to 24 (0h. is midnight, 12h. is noon). I have not brought the hours to a single uniform standard, in order to avoid introducing mistakes in copying, and especially because very few of the times are really accurate. Mr. Tennent's list is without doubt quite the best in this regard. Since January 1, 1887, all the stations of the Southern Pacific Railroad, and since August, 1887, those of the Atlantic and Pacific Railway, receive a noon signal (Pacific standard time) from the Lick Observatory or from the

* i. e. Greenwich time *minus* 8 hours.

U. S. Naval Observatory at Mare Island, and since this date, therefore, there is more likelihood that the times in this catalogue are accurate. *Third*, the place or places where the shock has been felt. Here the abbreviation "S. F." stands for San Francisco. When necessary the name of the county is added for convenience. *Fourth*, the intensity of the shock, expressed either in common language or in terms of some arbitrary scale. Professor Rockwood, in indicating the intensity, has used the adjectives: 1, very light; 2, light; 3, moderate; 4, strong; 5, severe; 6, destructive; but has added a Roman numeral to indicate the intensity, according to the Rossi-Forel scale, adopted by Swiss and Italian seismologists. In Professor Rockwood's papers, very light is II or III; light, IV; moderate, V or VI; strong, VII or VIII; severe, VIII; destructive, IX or X.

Fifth—A brief reference to the source of information, so that in nearly all cases the original record can be consulted, if desired. Exceptionally heavy shocks, such as those of 1865, 1868 and 1872, are treated with much more fullness than the lighter ones.

I strongly recommend the use of the Rossi-Forel scale, on account of the definiteness of the classification and because of the comparative regularity of the gradations. In order to make it better known in California, I reprint it here:

THE ROSSI-FOREL SCALE.*

I.

Microseismic shock—recorded by a single seismograph, or by seismographs of the same model, but not putting seismographs of different patterns in motion; reported by experienced observers only.

* First proposed by Rossi in *Archives des Sci. Phys. et Nat.*, IV, p. 371 (1880), and quite independently by Forel, *ibid.*, VI, p. 461. After comparing hundreds of published accounts of California earthquakes, I have found that the words here printed in *italics* (which form no part of the Rossi-Forel scale as proposed by its authors) are frequently employed by California observers. They are here printed for convenience. When any one is describing the effect of a shock he should employ the numerals I, II, III, etc., of the Rossi-Forel scale. When, on the other hand, one is reading an account of a California earthquake and seeking to assign the proper R.-F. numeral, it will be found that the words here set down in *italics* are of service.

II.

Shock recorded by several seismographs of different patterns; reported by a small number of persons who are at rest. *A very light shock.*

III.

Shock reported by a number of persons at rest; duration or direction noted. *A shock; a light shock.*

IV.

Shock reported by persons in motion; shaking of movable objects, doors and windows, cracking of ceilings. *Moderate; sometimes strong: sharp; light.*

V.

Shock felt generally by every one; furniture shaken, some bells rung, *some clocks stop.* *Smart; strong; heavy; severe; sharp; quite violent; some sleepers waked.*

VI.

General awakening of sleepers; general ringing of bells; swinging of chandeliers; stopping of clocks; visible swaying of trees; some persons run out of buildings; *window-glass broken.* *Severe; very severe; violent.*

VII.

Overturning of loose objects; fall of plaster; striking of church bells; general fright, without damage to buildings; *nausea.* *Violent; very violent.*

VIII.

Fall of chimneys; cracks in the walls of buildings.

IX.

Partial or total destruction of some buildings.

X.

Great disasters; overturning of rocks; fissures in the surface of the earth; mountain slides.

The Lick Observatory will be glad to receive corrections or additions to the list of shocks catalogued.

The information can be very conveniently given by answering the following questions, which are copied from a circular prepared by Captain C. E. Dutton, U. S. A., for the U. S. Geological Survey:

1. Post Office address; town, county, and State.
2. Place and date of observation.
3. Name and address of the observer, if other than the writer.
4. Position and occupation of observer at time of the shock, and character of the ground. State whether observer was in the house or out of doors; what kind of a house (wooden or stone); up stairs or down; what doing at the time; whether the ground at surface was rock, clay, sand, or loam; about how far down to solid rock.

NOTE.—If the shock was not felt in your neighborhood, although noticed at places not very far distant, do not fail to answer these first four questions, as negative reports are of great interest in defining the limits of the disturbed area, etc. State also the nearest point to your station where the shock was felt.

5. State as exactly as possible the *time of commencement* and the *duration* of each shock.

The exact time of the beginning of a shock (to the nearest second), one of the most important of all observations, is difficult to get correctly, because of the great velocity with which the wave travels (about three miles a second), and because the watch or clock must be immediately compared with a clock known to be keeping standard time. If several hours have elapsed before the comparison is made, another comparison should be made an hour later, in order to find whether your timepiece is gaining or losing, and how much. Unless it is stated that this has been done, the observation cannot be regarded as a good one till confirmed by other reports. Telegraph operators, railroad officials, watchmakers, etc., have especially good opportunities for answering this question correctly, and their coöperation is most earnestly solicited.

6. Give any facts that you can as to sounds accompanying shocks and as to the direction in which the earthquake wave seemed to travel.

If any sound, other than the mere creaking of woodwork, etc., accompanied the shock, state as fully and accurately as possible whether it preceded, accompanied, or followed the shock, and what interval there was, if any; also what the sound was like. Describe

the character of the shock, whether a tremor or an undulatory motion, etc., and whether you yourself or others had any clear impression as to the direction in which it was moving, the facts upon which this impression was based, and whether people agreed as to the direction.

7. Which number on the Rossi-Forel scale of earthquake intensity best expresses the intensity of the shock in your vicinity?

8. Give, also, any further particulars of interest, whether they are from observation or from hearsay.

If a chandelier was noticed to swing, describe it, and state the direction and amount of swing. If pictures swung, state direction of wall, and whether pictures on other walls at right angles to the first were also put in motion. If doors were closed or opened by the shock, state the direction of the wall in which they are set. If a clock was stopped, give the exact time it indicated (and anything known, as how fast or how slow it was), its position, the direction in which it was facing, and the length of the pendulum. If any changes occurred in the ground, such as depressions or elevations of the surface, fissures, emissions of sand or water, describe them fully. Mention any unusual condition of the atmosphere; any strange effects on animals (it is often said that they will feel the first tremors of a shock before people notice it at all); character of damage to buildings, general direction in which walls, chimneys, etc., were overthrown. Springs, wells, and rivers are often noticeably affected even by slight shocks, and any information in regard to such changes will be valuable.

9. Name of the writer.

NOTE.—In replying to these questions, they need not be repeated; but the answers should be *numbered* to correspond to the questions."

The lists which follow give recorded earthquakes in their chronological order. It is desirable to arrange the statistics in various ways—by years, by months, by seasons, etc.—in order to exhibit any periodicity there may possibly be in the phenomena. It is a favorite hypothesis that shocks follow in cycles; and this is true of some regions, apparently.

The tables A, B, C were prepared for the first edition of this book, and are here reprinted without change. The addition of the data since 1887 would not alter the conclusions to be derived from them.

TABLES OF THE NUMBER OF EARTHQUAKES WHICH ARE RECORDED
IN EACH MONTH OF EACH OF THE YEARS 1850-1887, IN CALI-
FORNIA, WASHINGTON AND OREGON.

In the three following tables I have counted the days in each month of each year on which shocks (supposed to be different) have occurred. For example, a shock felt at a given hour at San Francisco and at Oakland is counted as one; but shocks at different places, as San Diego and San Francisco, on the same day, are counted separately when they are not *known* to be parts of the same phenomenon.

TABLE (A) OF THE NUMBER OF EARTHQUAKES WHICH ARE RECORDED IN
CALIFORNIA, OREGON, ETC., IN THE YEARS 1850-1887.

YEAR.	Total.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1850.....	8	1	1	1	...	1	1	...	2	1	...	...	...
1851.....	15	...	1	1	3	1	...	...	...	...	...	4	5
1852.....	6	...	...	1	...	...	...	...	...	...	...	3	2
1853.....	22	4	2	1	2	...	1	1	...	1	3	4	3
1854.....	22	2	1	2	3	4	1	3	1	1	3	1	1
1855.....	14	2	1	...	1	...	2	2	2	...	2	...	2
1856.....	25	5	1	3	1	3	...	...	5	2	1	2	...
1857.....	31	6	1	3	1	3	1	1	2	2	2	6	3
1858.....	10	...	2	...	...	...	...	...	2	5	...	1	...
1859.....	19	1	...	1	1	...	...	...	5	4	1	2	4
1860.....	20	2	1	3	5	2	1	...	...	3	...	2	1
1861.....	11	2	...	2	2	...	1	2	...	...	1	...	1
1862.....	19	1	...	1	...	5	8	1	...	1	1	...	1
1863.....	17	4	2	...	...	...	2	4	1	...	1	...	3
1864.....	22	...	1	4	...	2	2	4	2	3	3	...	1
1865.....	42	3	2	6	4	1	1	...	2	3	16	2	2
1866.....	24	1	3	4	...	3	3	1	2	1	...	1	5
1867.....	6	1	1	...	1	...	...	...	...	1	...	1	1
1868.....	54	...	1	...	6	2	1	3	26	10	3	2	...
1869.....	31	4	2	1	2	2	4	2	...	4	5	...	5
1870.....	19	2	3	2	6	3	...	...	2	1	...	...	...
1871.....	19	...	1	2	1	1	2	5	2	3	2	...	1
1872.....	41	...	3	7	15	2	1	...	1	2	5	2	3
1873.....	15	...	2	1	3	1	1	1	1	...	2	2	1
1874.....	10	2	...	2	...	1	1	...	2	...	...	...	2
1875.....	17	1	1	...	...	3	...	1	...	1	5	5	...
1876.....	7	1	...	1	...	1	...	...	1	...	2	...	1
1877.....	16	2	1	...	...	2	1	2	3	3	1	1	...
1878.....	17	...	1	2	1	2	1	2	...	3	2	1	2
1879.....	8	...	2	...	...	2	...	...	2	...	1	...	1
1880.....	26	1	...	2	3	1	1	...	2	1	...	5	10
1881.....	23	7	3	1	2	...	1	2	1	1	2	3	...
1882.....	26	1	1	5	2	1	1	3	4	1	5	1	1
1883.....	28	2	1	3	1	...	...	2	2	4	7	1	5
1884.....	27	4	...	2	5	...	3	1	3	3	3	3	...
1885.....	39	5	5	2	7	1	3	4	...	2	3	1	6
1886.....	12	1	...	...	...	3	1	2	...	1	2	1	1
Sums.....	768	68	45	66	71	56	51	45	53	85	88	57	83

As many of the earthquakes of California are very local phenomena, which depend upon local causes for their production, we cannot expect to obtain very definite laws from a table like this which covers the whole of such a vast territory. Moreover, the facilities for gathering information in the thinly settled portions of the State were imperfect in the earlier years, and even now shocks are not carefully recorded at more than two or three places in the State. For these and other reasons this table can only give approximate results. It does not include every single earthquake set down in the catalogue, since it was compiled before the list was entirely finished. It, however, contains nearly all. It is sufficiently full for its purpose, which is simply to show the relative frequency of shocks in the various months. This is for:

1850-1887.	January.....	68	182, near Vernal Equinox (1850-1887). (Rainy Season.)
	February.....	45	
	March.....	66	
	April.....	71	
	May.....	56	
	June.....	51	
	July.....	45	
	August.....	53	
	September.....	85	
	October.....	88	
	November.....	57	
	December.....	83	
	January.....	68	(Rainy Season.)

Rainy season, 390; dry season, 378. *Thus for California, Oregon and Washington at large, shocks are about equally probable in the wet and in the dry season.* Table A includes the data derived from observations at San Francisco. If we form a similar table which includes all the data for California, Oregon, etc., *excluding* San Francisco, the result will be, for:

1850-1887.	January.....	43	119, near Vernal Equinox. (Rainy Season.)
	February.....	23	
	March.....	40	
	April.....	56	
	May.....	39	
	June.....	34	
	July.....	32	
	August.....	42	
	September.....	64	
	October.....	53	
	November.....	27	
	December.....	61	
	January.....	43	(Rainy Season.)

Rainy season, 250; dry season, 264. (See the last column of Table B.)

TABLE (B) OF THE NUMBER OF EARTHQUAKES WHICH HAVE BEEN RECORDED
IN EACH MONTH OF EACH OF THE YEARS 1850-1887 IN SAN FRANCISCO.

YEAR.	Total.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total in California except S. F.
1850...	5	1	1	...	...	1	1	...	...	1	...	...	...	3
1851...	10	...	...	...	...	2	1	...	...	...	4	3	5	5
1852...	1	...	...	...	...	...	...	...	...	...	1	...	...	5
1853...	5	1	1	1	...	...	...	...	...	...	2	1	17	17
1854...	8	1	1	1	2	1	...	...	...	2	...	...	...	14
1855...	3	...	...	...	...	...	...	...	...	1	1	...	1	11
1856...	10	4	1	2	...	1	...	1	...	1	1	...	...	15
1857...	17	1	1	2	...	...	1	...	2	2	5	3	3	14
1858...	7	...	1	...	...	...	...	...	2	3	...	1	...	3
1859...	8	...	...	...	...	...	...	...	1	2	1	2	2	11
1860...	9	1	1	...	2	1	...	...	2	...	1	1	1	11
1861...	4	...	...	1	1	...	1	1	...	...	...	...	...	7
1862...	2	...	...	...	...	...	...	...	...	1	...	1	...	17
1863...	8	1	...	...	...	...	1	2	1	...	...	3	...	9
1864...	16	...	1	3	...	2	2	3	...	3	1	...	1	6
1865...	23	...	2	4	3	1	...	...	1	...	9	1	1	19
1866...	9	1	2	1	...	1	1	1	...	...	...	...	1	15
1867...	2	1	...	...	...	...	...	...	...	1	...	...	...	4
1868...	14	...	...	1	...	1	1	1	...	...	7	3	1	40
1869...	10	2	2	...	1	2	3	...	...	...	...	...	...	21
1870...	8	1	3	4	...	...	...	...	...	...	...	...	...	11
1871...	2	...	1	...	1	...	...	...	...	...	...	...	...	17
1872...	5	...	1	...	1	...	...	...	1	...	3	...	...	36
1873...	4	...	2	...	1	...	...	...	...	...	1	...	...	11
1874...	6	2	...	1	...	1	1	...	...	...	1	3	...	4
1875...	8	...	1	...	...	...	3	...	...	...	1	...	...	9
1876...	2	1	...	...	...	...	...	...	...	1	...	...	...	5
1877...	2	...	...	...	...	1	...	...	1	...	...	...	...	14
1878...	4	...	1	...	...	...	...	...	2	...	1	...	...	13
1879...	1	...	1	...	...	...	...	...	...	...	...	...	...	7
1880...	4	...	1	...	1	1	1	...	...	...	1	...	...	22
1881...	5	1	...	...	1	1	1	...	...	1	1	2	...	18
1882...	9	...	1	...	1	1	...	1	2	1	3	...	...	17
1883...	6	1	...	1	1	...	...	...	...	...	3	...	...	22
1884...	5	2	...	2	1	...	...	...	...	...	1	1	1	22
1885...	5	2	...	...	...	...	...	...	...	...	1	1	1	34
1886...	7	1	...	...	1	1	...	...	...	1	1	1	1	5
Sums.	254	25	22	26	15	17	17	13	11	21	35	30	22	514

The number of shocks recorded at San Francisco in the separate months (1850-1887) are:

1850-1887.	January.....	25		
	February.....	22	63, near Vernal Equinox.	
	March.....	26	(Rainy Season.)	
	April.....	15		
	May.....	17		
	June.....	17	47, near Summer Solstice.	
	July.....	18	(Dry Season.)	
	August.....	11		
	September....	21	67, near Autumnal Equinox.	
	October.....	35	(Dry Season.)	
	November....	80		
	December....	22	77, near Winter Solstice.	
	January.....	25	(Rainy Season.)	

Rainy season, 140; dry season, 114. *Shocks in San Francisco are considerably more frequent in the rainy season than in the dry, contrary to the rule for the State at large.* The average number of shocks per month is $\frac{34}{12}$. *January, March, October and November have decidedly more shocks than the average; April, July and August have decidedly fewer than the average.*

A comparison of the monthly totals for San Francisco and for California (excluding San Francisco) seems to indicate that the causes of most San Francisco earthquakes are local and not general in their nature. The records from which this table has been derived are so full that considerable weight must be allowed to the conclusions drawn from it.

As San José is situated near to Mount Hamilton, where accurate earthquake observations will be carried on for many years to come, it is desirable to examine the earthquake records for San José and Santa Clara as carefully as may be.

TABLE (C) OF THE NUMBER OF EARTHQUAKES WHICH ARE RECORDED IN EACH MONTH, OF THE YEARS 1850-1887, IN SAN JOSÉ AND SANTA CLARA.

YEAR.	Total.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Shocks in S. F.
1850....	3			1		1				1				5
1851....	0													10
1852....	0													1
1853....	2											2		5
1854....	0													8
1855....	0													3
1856....	1		1											10
1857....	4	1			1						1	1		17
1858....	3								2		1	1		7
1859....	4				1				2				1	8
1860....	0													9
1861....	0													4
1862....	0													2
1863....	3			1				2					1	8
1864....	5		1	1			1		1				1	16
1865....	4										4			23
1866....	9		1									1		9
1867....	0													3
1868....	1										1			14
1869....	4		1	1	1		1							10
1870....	1		1											8
1871....	1		1											3
1872....	1			1										5
1873....	3		1					1					1	4
1874....	1							1						6
1875....	2								1		1	1		8
1876....	2	1									1			2
1877....	0													2
1878....	1										1			4
1879....	0													1
1880....	2				1							1		4
1881....	1											1		5
1882....	0													9
1883....	0													6
1884....	1			1				1						5
1885....	2							1					1	5
1886....	0													7
Sums.	61	2	7	5	3	2	1	4	4	4	9	8	5	254

The data for San José and Santa Clara are far less full than for San Francisco. Probably an equal number of shocks has occurred at each place, but the records of San Francisco (which are well kept) show about four times as many shocks as are shown by the San José records (which have not been carefully kept).

The distribution of shocks in the various months is as follows, for:

1860-1887.	January.....	2	
	February.....	7	{ 15, near the Vernal Equinox.
	March.....	5	{ (Rainy Season.)
	April.....	3	
	May.....	2	{ 7, near the Summer Solstice.
	June.....	1	{ (Dry Season.)
	July.....	4	
	August.....	4	{ 17, near the Autumnal Equinox.
	September....	4	{ (Dry Season.)
	October.....	9	
	November....	8	{ 15, near the Winter Solstice.
	December....	5	{ (Rainy Season.)
	January.....	2	

Rainy season, 30; dry season, 24. *Like San Francisco, and unlike California at large, San José seems to have more shocks in the rainy season.*

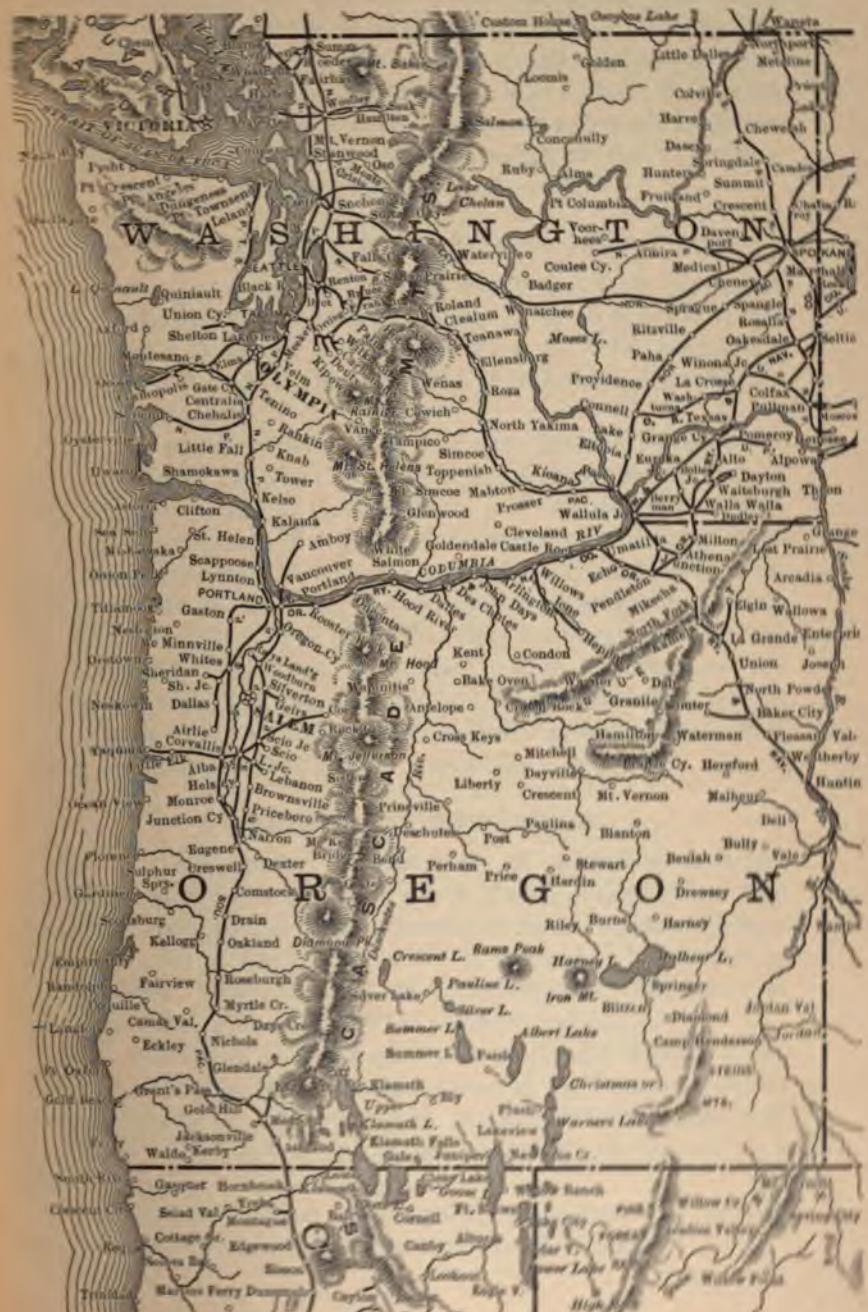
The average number of shocks per month is $4\frac{1}{2}$ divided by 37. February, October and November have decidedly more shocks than the average; January, May and June have decidedly fewer than the average. July and August have (unlike San Francisco) the average number of shocks. If the data are sufficient to draw any conclusion from (which very probably they are not), this would show that the shocks at San José are local, and that they are, in general, not dependent upon the same cause as those of San Francisco.

Similar tables can be formed for the places where the catalogue shows shocks to be relatively frequent, as Humboldt, Los Angeles, Oakland, San Diego, Monterey, Santa Cruz, Sacramento, etc., and, so far as the data are sufficient, the same result will be indicated, namely, that the light earthquakes common in California are usually rather local than general and widespread phenomena. A curious example of this is the exemption of Santa Barbara from shocks in the years 1860-1872. Before 1860 and after 1872 Santa Barbara was subject to shocks, precisely as other places in the same region, while between these years no shock is recorded. There is no reason to believe that the records were not equally well kept during the whole period.

The immediate and practical conclusion to be drawn from the above tables is that in any future study of California earthquakes we ought to select special regions for examination, as the Valleys of

Earthquakes on Pacific Coast.—Holden.

PLATE II.



MAP OF WASHINGTON AND OREGON.

Santa Clara, Napa, San Joaquin, Salinas, Amador, Clear Lake, Pitt River, etc., rather than to attempt wider ranges. It may thus be possible to fix the origin of the local shocks, and finally to be reasonably certain of its permanency. It also appears to me that the data seem to indicate that the greater number of California earthquakes have been the result of faulting in the underlying strata rather than due to volcanic causes directly.

EARTHQUAKE SHOCKS FELT AT SEA OFF CAPE MENDOCINO, ETC.

The list of recorded earthquakes contains notices of several shocks reported in this general neighborhood, as follows: 1868, May 18; 1870, December 4; 1873, November 22; 1876, August 16; 1877, October 26; 1884, June 12; 1884, November 4; 1895, March 1, October 24.

A relief map of the ocean bed near Cape Mendocino, made by Professor George Davidson and Mr. Winston, shows the coast to be very "steep-to"; and it further shows two submarine mountains in the neighborhood. The slipping of the earth at the junction of the steep submarine cliff with the (comparatively) flat ocean floor, may very well be the cause of some of these disturbances. It is also possible, on the other hand, that they are connected with the two submarine elevations mentioned. More observations are needed to decide this question. It is a little remarkable that we have reports of shocks felt at sea in this vicinity and none, or few, at other points along the coast. (See Plate V, page 31.)

SELF-REGISTERING SEISMOMETERS.

The Lick Observatory possesses a set of earthquake recorders made from the designs of Professor J. A. Ewing of Cambridge. The following description of them is extracted from Professor Ewing's note in *Nature* of August 12, 1886. A similar set is installed in the Students' Observatory of the University of California at Berkeley. (See Plates III and IV, pages 18 and 20.)

(1) A Horizontal Seismograph, with clock and driving plate. The clock is started by an electric contact at the beginning of the earthquake, and the two rectangular components of the horizontal motion (N and S, and E and W) are registered side by side on a rotating plate.

(2) A Vertical Motion Seismograph, to register the vertical movement of the surface of the earth on the same plate.

(3) A Duplex Pendulum Seismograph, to give independent records of the horizontal motion on a fixed plate, the pencil being free to move in all azimuths.

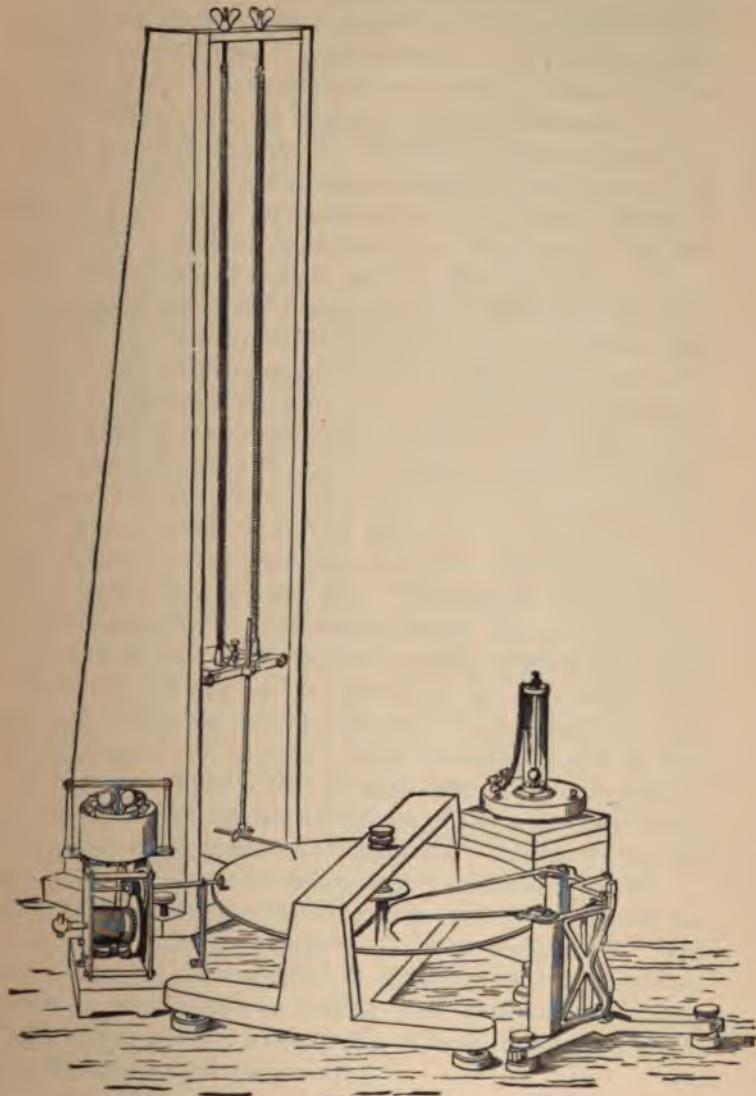
(4) A Chronograph attachment, which is set in motion at the beginning of a shock, and records the time of its occurrence. It also marks the clock seconds upon the revolving plate of No. 1.

"In the design of these seismographs the object has been kept in view of making them easily capable of use by observers who have not made seismometry a special study. They are entirely self-recording, and require little attention during the long intervals which must, in most situations, be expected to elapse between one period of activity and the next.

One group of instruments is arranged to give a complete record of every particular of the movement, by resolving it into three rectangular components—one vertical and two horizontal—and registering these by three distinct pointers on a sheet of smoked glass which is made to revolve uniformly by clockwork. A single earthquake always consists of many successive displacements of the ground; hence the record traced by each pointer on the moving plate is a line comprising many undulations, generally very irregular in character. The amplitude, period, and form of each of these are easily measured, and by compounding the three we obtain full information regarding the direction, extent, velocity and rate of acceleration of the movement at any epoch in the disturbance.

This group of instruments is shown in Plate III. In the centre is the plate of smoked glass, which gets its motion through a friction-roller from a clock* furnished with a centrifugal governor, acting by fluid-friction, and balanced so that its speed is not sensibly affected by the shaking of the ground. The clock is started into motion by means of a Palmieri seismoscope, which appears in the figure, behind the plate, on the right. This is a small common pendulum, whose bob carries at the bottom a piece of stiff platinum wire that projects into a recess in a cup of mercury below—the recess being formed by an iron pin standing lower than the surface of the surrounding mercury. On the slightest shaking of the ground, contact with the edge of the mercury takes place, and this closes a circuit which releases an electro-magnetic detent and starts

* At the left-hand side of the cut.



COMPLETE THREE-COMPONENT SEISMOGRAPH, FOR MOTIONS IN ALL DIRECTIONS.

The three pens are steady during a shock, while the glass plate moves to and fro with the earth, and at the same time is made to rotate by the clock (at the left hand in the cut). The steady pens mark the components of the earth's motions on the smoked surface of the revolving plate.

the clock. This occurs during the preliminary tremors which are usually found in advance of the main movements of an earthquake. The same circuit starts another clock* (of the escapement type) which fulfills two functions. It marks time on the revolving plate during a part of the first revolution, and then continues to go as an ordinary clock, so that, by inspecting its dial afterwards, the interval which has elapsed since the occurrence of the earthquake is known, and the date of the shock in hours and minutes is thus determined with as much precision as the phenomenon admits of. This part of the apparatus is omitted from the figure. The two horizontal components of motion are recorded by a pair of horizontal pendulums, set at right angles to each other, but with their indices inclined so that they write side by side on one radius of the plate. The pendulums are supported on a single stand, but with independent adjustments for position and stability. Each has two pivots, consisting of hard steel points, which turn in sapphire centres. At the pivots and at the tracing-points every effort has been made to avoid friction. The indices are of aluminium, and a part of their weight is taken by springs (not shown in the figure), so that their pressure on the plate may be no greater than is necessary to produce a trace on the sooty film. The vertical component of motion is recorded by the instrument which appears behind the clock. A massive bar, free to move vertically about a horizontal axis, is held up by a pair of long spiral springs. Its equilibrium is made nearly neutral by applying the pull of the springs at a suitable distance below the horizontal plane through the axis of support. A bell-crank lever with a jointed index gives a multiplied trace of the apparent vertical oscillations of the bar, which correspond to vertical displacements of the ground. In this instrument, as in the others, sapphire centres are used to minimize friction.

Records inscribed on the plate are preserved by varnishing the plate and using it as a 'negative' to print photographs. The motion, as recorded, is magnified to an extent which experience has shown to be desirable in dealing with disturbances ranging from those which are just recognizable as earthquakes up to those which are to some extent destructive.†

* Not shown in the cut.

† In the Lick Observatory instrument the horizontal components are multiplied 3.3 times and the vertical component is multiplied 1.6 times. The indices are made of stout straws.

Another and distinct instrument is the duplex pendulum seismograph, shown in Plate IV. A massive bob is hung by three parallel wires from the top of a three-cornered box, and is reduced to nearly neutral equilibrium by being coupled by a ball-and-tube joint to the bob of an inverted pendulum below it. The two form a system which can be made as nearly astatic as is desirable, and so furnish a suitable steady-point for the horizontal part of earthquake movement in any azimuth. The motion is magnified* and recorded by a vertical lever geared to the upper bob by a ball-and-tube joint, supported on gimbals from a bracket fixed to the box, and furnished with a jointed index which writes on a fixed plate of smoked glass. Records of the kind which the duplex pendulum gives are of course incomplete in two important particulars: they show nothing of the vertical motion (which, however, is usually a comparatively small part of the whole), and they show nothing of the relation of *time* to displacement throughout the disturbance. But they exhibit very clearly the change of direction which the movements undergo, and the actual direction taken by any pronounced element of the shock."

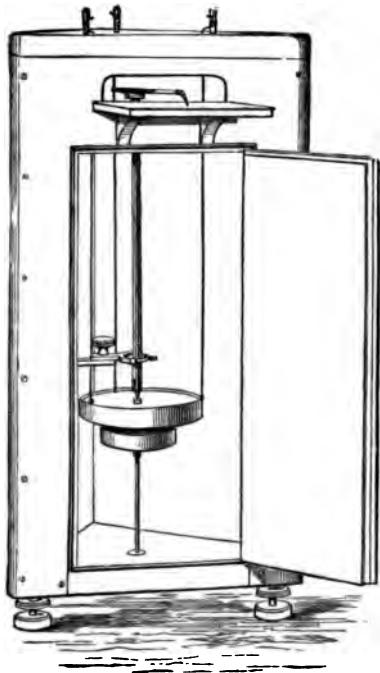
These instruments have been kept in working order at Mount Hamilton since June, 1888.

The larger instrument is somewhat complicated and is not suitable for private establishments, where its care would require too much time. The smaller seems to be what is wanted for a general instrument to record (the horizontal components of) shocks of average intensity.

I have had a copy made of it, with some simplifications and improvements, and such copies can be purchased from Paul Seiler's electrical works, 406 Market Street, San Francisco, for \$15.

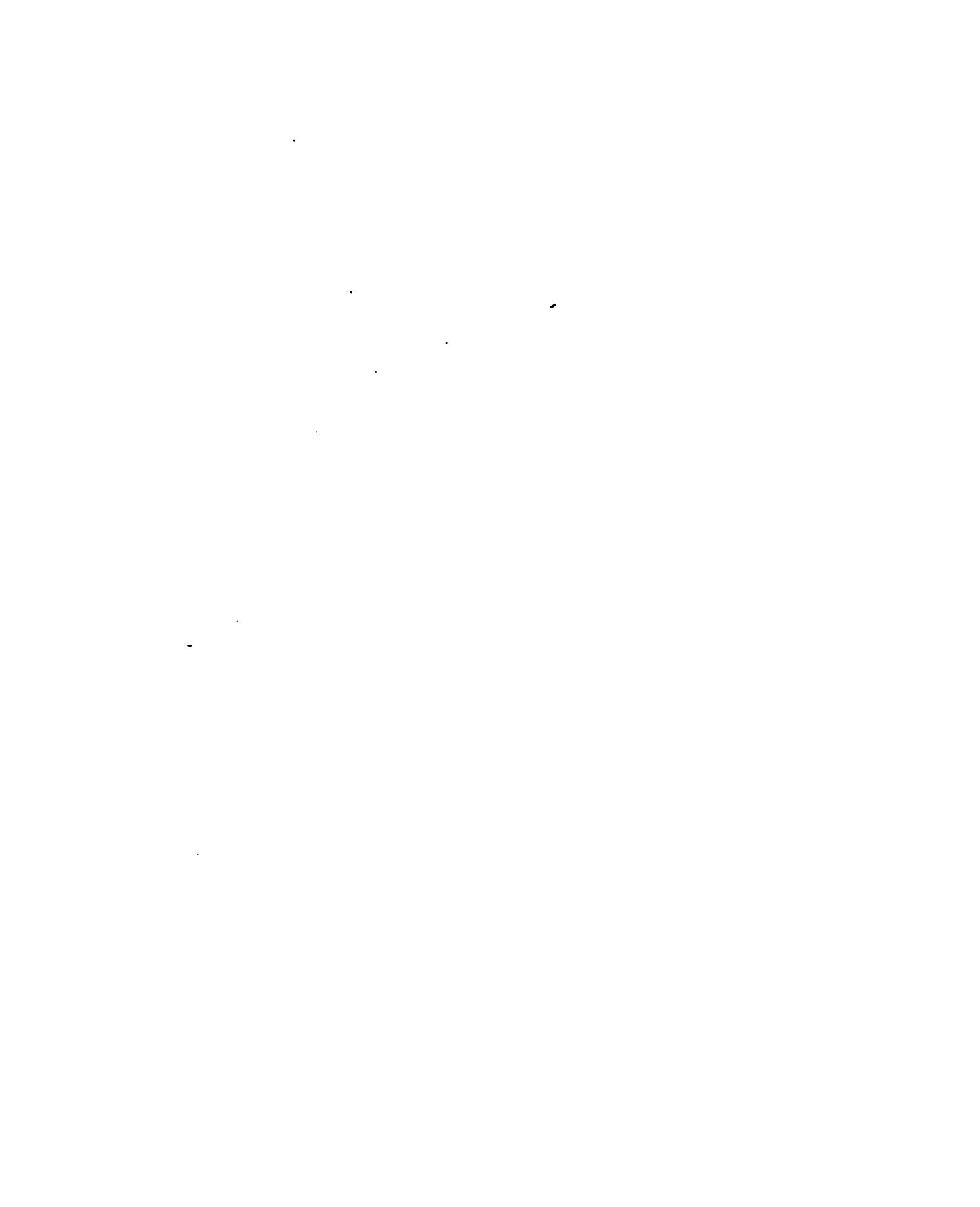
Such copies have been set up in California at various places, among others at the Cliff House, S. F. (Hon. A. Sutro), Kono Tyee, Lakeport (Miss Floyd), Chabot Observatory, Oakland (Mr. Charles Burckhalter), Students' Observatory, Berkeley (Professor Frank Soulé), Highland Park, East Oakland (Mr. F. G. Blinn), University of the Pacific, San José (the Professor in charge of the Observatory), Stanford University (Professor Branner), Mills Seminary, Oakland (Professor Keep). Other copies have been sent

* In the Lick Observatory instrument the horizontal components are magnified 4 times.



DUPLEX PENDULUM SEISMOGRAPH FOR HORIZONTAL MOTIONS.

During a shock the pen is steady and writes the trace of the horizontal motions of the earth on the moving plate of smoked glass (on the shelf near the top of the instrument-case).



out of the State, for example: to Cleveland, Ohio (Warner and Swasey), Washington, D. C. (U. S. Geological Survey), Carson, Nevada (Professor C. W. Friend), Readville, Mass. (Blue Hill Observatory), *Santiago de Chile (National Observatory), *Mexico (Tacubaya) (National Observatory), *Cordoba, Argentine Republic (National Observatory), *Greenwich, England (Royal Observatory).

It may be useful to print in this place the following brief instructions for setting up the Duplex Seismometer, which were prepared by Dr. Joseph Le Conte and myself in 1887 and sent out with the first instruments:

USE OF THE EWING DUPLEX SEISMOMETER.

" The object of the instrument is to automatically register on a smoked glass plate the horizontal motions of the earth below its base.

" The best way to set up the instrument is to drive a post into the ground about four feet. The top of the post should be sawed off square as near to the ground as convenient, a piece of stout plank spiked to it, and the three leveling-post screws of the instrument placed on this. The screws should be turned until the two pendulums hang freely at equal distances from the frame all around, and until the pointer or index is near the centre of the glass plate. A line marked N—S on this plate should be put in the north and south line (N to the north).† If the instrument cannot be placed at the surface of the ground, it should be placed as near to the surface as possible (since it is desired to register the movements of the ground and not the oscillations of any particular house or part of a house), and it should always be placed on a post firmly set in the ground when this can be done. If this is not practicable, it should be placed in the best position attainable. It is convenient to have the instrument protected by a glass case. The glass plate should be smoked on one side by holding it above the flame of a lamp or candle (burning camphor gives the best film of soot). The instrument is then ready for use.

" When a shock occurs, the base of the machine will be moved and

* Presented to the Observatory by Mateo Clark, Esq., of London.

† A line registered on the plate from the point of beginning towards N (if caused by a shock) means that the earth has itself moved north below the instrument.

the glass plate will move with it. The double pendulum is so constructed as to remain steady, or very nearly so; the pointer over the glass plate remains steady also, and writes the motion of the earth upon the moving plate. The motion of the earth is magnified approximately four times. The line traced on the plate will represent the *direction* of each shock, and the length of the line gives a measure of the *intensity*. In any large earthquake this line will be a looped curve. If the *time of beginning* of the earthquake is also noted by the observer on his watch, and if the watch is compared as soon as possible with the time of the nearest railway station (time is received daily at noon, at all railway stations, from the Lick Observatory), all the data are secured which are necessary for the accurate study of the shock at this one station. If the original glass plate is carefully packed (so as to preserve the film) and sent to the Director of the Lick Observatory, it will be measured at the Observatory, and a blue print of the tracing will be returned to the sender, together with the original glass plate. The memorandum relating to the time of the shock should also be sent, with a statement of exactly how and where the instrument is mounted. As soon as one glass plate is removed, the spare plate furnished with the instrument should be blackened and inserted. The only precautions necessary to be taken in the use of this instrument are to keep it level and to keep a freshly-smoked plate underneath the pointer."

During the years 1888-1897 the large Ewing seismograph of the Lick Observatory has been under the charge of Messrs. Keeler, Hill, A. J. Burnham and Perrine, and certain improvements in its construction have been suggested by experience. Some of these improvements have actually been made. The following memorandum has been prepared at my request.

IMPROVEMENTS IN THE EWING SEISMOPHYS SUGGESTED BY
EXPERIENCE.

BY C. D. PERRINE.

"Our experience with the Ewing seismograph of the Lick Observatory has suggested some slight changes to improve its working. The magnetic release for the driving clock has frequently failed to act, as a heavy current was required to move the armature, which

is heavy, while the leverage of the magnet is short and the releasing arm long. The magnet was removed from its old position and placed much nearer the point of release; the armature and movable lever were made much lighter, and, when tested, they were found to respond to a much lighter current than in the old form.

"The governor of the driving clock is of the conical pendulum type, with paddles attached to the arms, which work in a trough filled with oil. In an instrument where the clock is in operation but a small portion of the time this form of regulation is objectionable. In our instrument the oil was removed and small strips of rubber attached to the paddles so that they would rub against the bottom of the empty oil trough. This has worked satisfactorily, as there is no great accuracy required in the rate of this clock. A small double conical pendulum, such as is now used on chronographs by Warner and Swasey or Saegmüller, adapted to this particular case, would probably be most satisfactory.

"As the beats of the time-clock are registered on the edge of the plate, it would be much more convenient if the clock beat either seconds or half-seconds instead of about 95 times per minute, as at present.

"There was too much friction between the spring-pen used to record the clock beats on the plate, owing to inequalities in the glass plates. Less friction and more uniform beats were secured by hinging the pen so that it had a considerable range vertically.

"The pen for recording the vertical motion has considerable 'creep,' probably owing to changes in the springs due to temperature, but this is not a matter of much importance if the instrument is always started by the shock. A small lever has been attached to the front of the case of the Duplex Seismograph in such a way that the pen can be raised mechanically and held out of the way while the plate is being changed."

March 29, 1897.

Quite a number of reports have been received of late years from the instruments installed in California and Nevada, and these records are of value. It would be of extreme interest if a series of such machines could be distributed around the Santa Clara valley, so as to encircle it on both sides, and so as to be situated on like geological strata. A line of instruments in the valley from Gilroy

to San Francisco, and another line on the east side of the bay, would be required. A few years' observations carefully studied would, I think, bring out results of consequence. The basin of Clear Lake should be studied in the same way, as its shocks appear to be of a special class.

REPORTED VOLCANIC ERUPTIONS ON THE PACIFIC COAST.

The list of shocks printed in 1887, and those compiled during succeeding years, contained many reported "eruptions" of mountains in the Puget Sound region. For a number of years I made it my business to apply by letter to intelligent observers in that neighborhood to determine whether Mount Baker and other mountains had ever certainly been known to be in eruption. Clouds hanging over the summit, snow blown from the slopes, etc., might, in my own opinion, account for all the reported phenomena. Still it was not possible to be certain either way, and I have left the accounts of such eruptions as they were first printed.

In 1896 Mr. Frederick G. Plummer, C. E., was kind enough to copy from his papers a list of the eruptions of Alaska volcanoes (1690 to date) and of the reported eruptions of the mountains around Puget Sound. This list was printed in the *Publications* of the Astronomical Society of the Pacific and is reprinted here. I have not incorporated this data in the catalogue of earthquakes which follows; it is more convenient in its present shape. Particular attention is called to the introductory paragraphs of Mr. Plummer's valuable list. Reports in the newspaper press on this subject are never decisive. To establish the fact of an eruption of one of the Puget Sound volcanoes it is necessary to have the report of an expert who was on the spot.

REPORTED VOLCANIC ERUPTIONS IN ALASKA, PUGET SOUND, ETC., 1690 TO 1896.

BY FREDERICK G. PLUMMER.

TACOMA, WASHINGTON, *March 13, 1896.*

"There can be no doubt that many eruptions are reported which might be contradicted if examination were possible. For example, the reports of the eruption and change in the summit of Mount Tacoma from November 21 to December 25, 1894, filled many

columns of the press dispatches, and possibly were intended for that purpose. December 25th was the most perfect day for observation, and, with my 6½-inch refractor, the crater-peak and its surroundings were carefully examined, and no change could be seen. No eruption was noted, other than the usual emission of steam, which varies with the barometer. However, reports came in later from a press party which claimed to have reached the slope of the mountain and witnessed an eruption of smoke. The party was about five miles from the summit, and my telescope, with low power, brought the summit within half a mile. Although this was the clearest and most definite report of eruption, yet it is so flatly contradicted by the continuous telescopic observations and the later examinations of climbers, that it is omitted from the table."

DATE OF BEGINNING.		NAME OF VOLCANO.	DURATION OF ERUPTION.	PHENOMENA. A=ALASKA; O=OREGON; W=WASHINGTON.
Year.	Day.			
1690		Khaginak	A.	A crater formed.
1700		On Amak Island	A. 10 years	Occasionally active.
1741		Hiamna	A.	
1760		Adakh	A.	
1760		Gorelof	A.	
1760		Chechitno	A.	
1760		Atka	A.	
1760		Koniush	A.	Island rose.
1762		Pavloff	A.	
1763		Tanaga	A.	
1763		Kanaga	A. 7 years	Solfataras.
1768		Unalashka	A.	
1768		Medviednikoff	A.	
1768		Walrus	A.	
1770		Amukhta	A.	
1774		Four Craters	A.	
1775		Calder	A.	
1775		Unimak	A. 3 years	Flames and smoke.
1776	July	Sitignak	A.	Flames and smoke.
1778		Iliamna	A. 93 years	Occasionally smoke.
1778		Shishaldin	A.	
1784		Vsevidoff	A.	
1784	July	Chechitno	A.	
1786		Seguam	A. 4 years	
1786		Amukhta	A. 5 years	
1786		Kanaga	A.	Flames and smoke.
1786		Pavloff	A.	North crater fell in.

DATE OF BEGINNING.		NAME OF VOLCANO.	DURATION OF ERUPTION.	PHENOMENA. A=ALASKA; O=OREGON; W=WASHINGTON.
Year.	Day.			
1790		Akutna	A.	
1790		Vsevidoff	A.	
1790		Kanaga	A.	
1790		Semisphnol	A.	
1790		Makushin	A.	Occasionally smoke.
1790		Shishaldin	A.	Occasionally smoke.
1791	June	Tanaga,	A.	
1791	June	Kanaga	A.	
1792		Great Sitkin	A.	
1792	February?	Gorelof	A.	4 months. Flames.
1792	June 1	Semisopochnoi	A.	
1795		Unimak	A.	SW. crater exploded and fell in.
1796		Edgecombe	A.	
1796	May	Bogoslov	A.	Terrible eruption of flames
1796		Four Craters	A.	4 years
1796		Amak	A.	
1802		Makushin	A.	Flames and smoke.
1806		Bogoslov	A.	Lava flow.
1812		Sarycheff	A.	Violent eruption.
1817	April	Yunaska	A.	
1817		Umnak	A.	
1819		Wrangell	A.	
1819		Redoubt	A.	
1820		Rogoslov	A.	
1824		Shisldin	A.	
1824		Yunaska	A.	
1825	March 10	Isanotski	A.	
1826	October 11	Unimak	A.	
1827		Shisldin	A.	3 years
1827		Pogrumnoi	A.	2 years
1827		Koniushi	A.	
1827		Kanaga	A.	
1828		Little Sitkin	A.	2 years
1828		Akhun	A.	2 years
1828		Akutan	A.	2 years
1828		Tanak-Angunakh A.	A.	2 years
1828		Atka	A.	2 years
1828		Koniushi	A.	2 years
1828		Gorelof	A.	2 years
1830		Korovin	A.	
1830		Atka	A.	
1830		Yunaska	A.	
1830		Umnak	A.	
1830	November	Unimak	A.	Violent eruption.
1830		Veniaminoff	A.	
1831		St. Helens	W.	12 hours
1831		Hood	O.	
1832		St. Helens	W.	
1838		Shishaldin	A.	Flames.

DATE OF BEGINNING.		NAME OF VOLCANO.	DURATION OF ERUPTION.	PHENOMENA.
Year.	Day.			A=ALASKA; O=OREGON; W=WASHINGTON.
1838		Four Craters.....A.		
1838		Makushin.....A.		
1838		Akutan.....A.		
1838		Veniaminoff.....A.		
1838		Pavloff.....A.		
1839		St. Elias.....A.		
1840		Cinder Cone.....A.		Cinders.
1841		Tacoma.....W.		
1841		St. Helens.....W.		
1842		St. Helens.....W.	2 months	Smoke and light ashes.
1842		Baker.....W.		
1843	November 13	St. Helens.....W.	10 days	Flames and light ashes.
1843	November 13	Tacoma.....W.		
1843	December ?	St. Helens.....W.	85 days	
1844		Korovin.....A.		
1844		Makushin.....A.		
1846		Hood.....O.		
1846		St. Helens.....W.		
1846		Baker.....W.		
1847		Baker.....W.		
1852		St. Helens.....W.		
1853	January	Baker.....W.		Slight lava flow.
1854	February	St. Helens.....W.	70 days	
1854	August	Hood.....O.		
1854	Summer	Baker.....W.		Smoke and ashes.
1859	August 15	Hood.....O.	2 days	
1859		Baker.....W.		
1860		Baker.....W.		
1861		Olympus.....W.		
1865		Shishaldin.....A.		
1865		Makushin.....A.		
1866	September 23	Hood.....O.	15 days	
1869		Hood.....O.	3 hours	
1873	Oct. 19, 4 P.M.	Tacoma.....W.	7 days	
1880	May	Tacoma.....W.		
1880	December	Baker.....W.		
1884	June 16	Tacoma.....W.	2 hours	Steam.
1891	Autumn	Baker.....W.		
1891	August 2	Chimney Peak.....C.		
1891		Hozomeen.....W.		Flame and smoke.
1892	August 27	Veniaminoff.....A.	3 days	
1892		Bogoslov.....A.		
1893	March 9	Olympus.....W.		
1894	January 17	Jefferson.....O.		Smoke and steam.
1895	Autumn	Bogoslov.....A.		Flames and smoke.

CONCLUSION.

From the report of United States Surveyor-General Harden-
burg, for the year ending June 30, 1871, the following is extracted:

"The shocks of 1800, 1808, and 1812 in California appear to
have been about equal in force to the shock of 1868 (and it seems
there have been no shocks during a century of greater severity).

"It is fair then to consider the shock of 1868 as a standard of
the maximum force of earthquakes occurring in California during
the last one hundred years. On the hypothesis that earthquakes
are the results of natural laws, which operate with some degree of
regularity, it may be fairly presumed that a period of one hundred
years would, in all probability, give the extreme limit of the result
of the action of these laws. Hence, having learned from reliable
history and from observation the maximum strength of earthquakes
occurring in California during a century past, we may, from these
data, with some degree of confidence predict what their maximum
strength will probably be during the hundred years to come. It
will perhaps be no difficult matter to provide against any serious
damage from these unwelcome visitors, by so constructing build-
ings that they shall be proof against any such shock of earth-
quake as has occurred in California during the last hundred years.
Reasoning from the foregoing historical facts, I am firmly of the
opinion that the earthquakes of California are not so much to be
dreaded as is generally supposed; in fact, that they are far less
dangerous to life and property than are the hurricanes of the
South or the summer tornadoes of the North."

The earthquake of 1872, which occurred subsequent to the writ-
ing of this report, was far more severe than the shock of 1868, and
should be taken to represent the maximum severity of any shock
which has actually occurred in California during a century.

The *destructive* earthquakes on the Pacific Coast during the years
1769 to 1887 have been those of:

- 1800. October 11-31 (San Juan Bautista, etc.).
- 1812. October or December (San Juan Capistrano).
- 1818. ? (Santa Clara).
- 1836. June 9 and 10 (Monterey and northward).
- 1839. ? (Redwood City and San Francisco).
- 1857. January 9 (Ft. Tejon, Tulare, etc.).

- 1865. October 8 (San Francisco, etc.).
- 1867. January 8 (Klamath, etc.).
- 1868. October 21 (San Francisco, etc.).
- 1872. March 26 (Inyo County).

Probably the shocks of 1890, August 23 (Mono Lake) and of 1892, April 19-21 (Vacaville), should be included in this list. They are printed in the following one.

Extremely severe shocks have occurred:

- 1806. March 24 (Santa Barbara).
- 1812. December 21 (San Buenaventura).
- 1843. June 23 (California and Mexico).
- 1851. May 15 (San Francisco, etc.).
- 1852. November 9 (San Diego, Yuma, etc.).
- 1853. February 1 (San Luis Obispo County).
- 1853. October 23 (Eureka).
- 1855. January 24 (Sierra County).
- 1855. July 10 (Los Angeles County).
- 1856. January 2 (San Francisco).
- 1856. January 10 (Los Angeles County).
- 1856. February 15 (San Francisco).
- 1856. In the fall (Tulare County).
- 1856. December (San Diego County).
- 1858. November 26 (San José).
- 1861. July 3 (Amador).
- 1864. March 5 (Petaluma).
- 1865. May 24 (San Francisco).
- 1866. February 17 (Klamath).
- 1868. September 26 (Ukiah).
- 1869. October 8 (Ukiah).
- 1869. December 26 (Sacramento, Marysville).
- 1873. November 22 (Oregon and Washington Territory).
- 1885. January 30 (Honey Lake Valley).
- 1890. April 24 (Pajaro).
- 1890. August 23 (Mono Lake).
- 1891. October 12 (Sonoma).
- 1892. April 19-21 (Vacaville).
- 1893. April 8 (Newhall).

That is twenty-nine exceptionally heavy shocks (exclusive of what I have called destructive shocks) have occurred since 1800, or say, one every three and three-tenths years on the average, taking the whole region of many thousand square miles together. For any particular locality the number of really heavy shocks is quite small. Thus, at San Francisco there have been three destructive shocks and four exceptionally heavy earthquakes in one hundred years, although there have been very many slight shocks and tremors.

If we confine our attention to any other particular part of the State, the number of really heavy shocks occurring is very small indeed. When we take into account the whole damage to life and property produced by all the California earthquakes recorded, it is clear that the earthquakes of a whole century in California have been less destructive than the tornadoes or the floods of a single year in less favored regions.

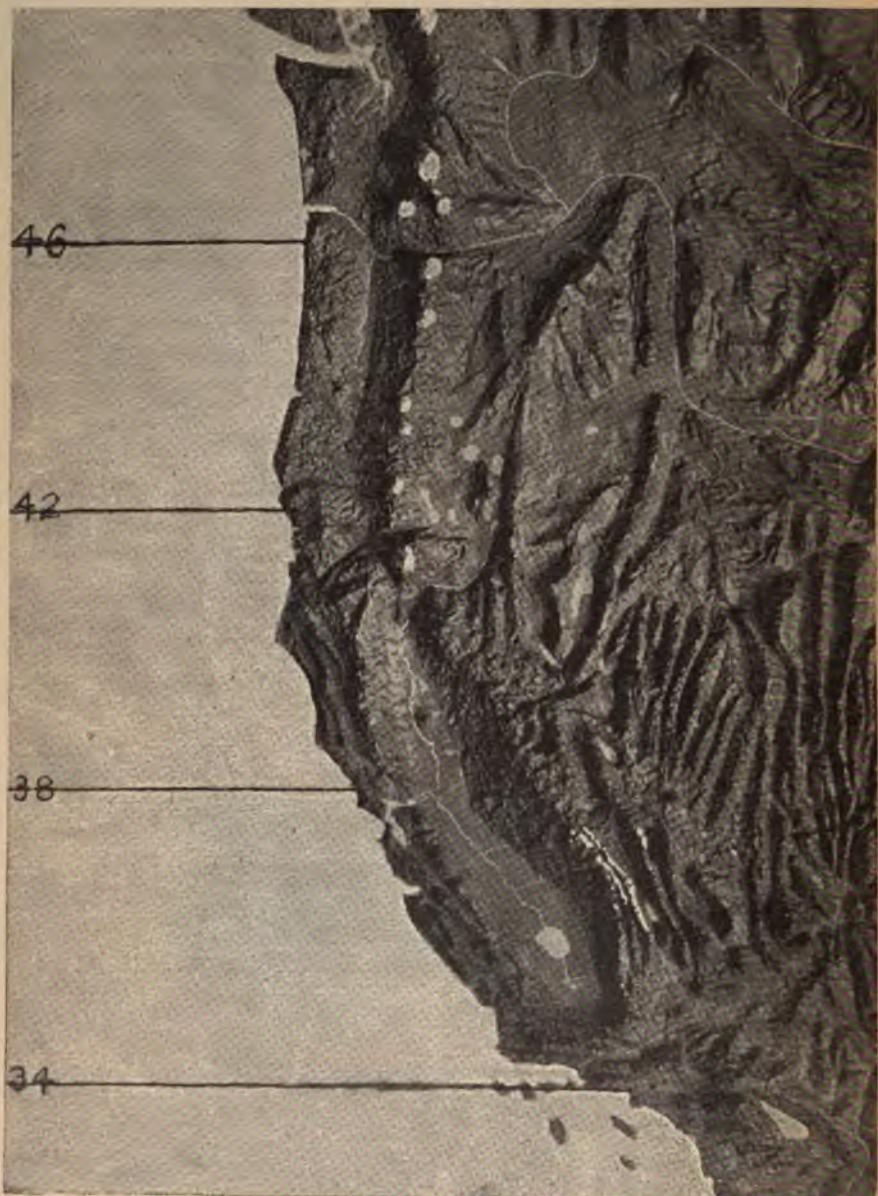
EDWARD S. HOLDEN.

Lick Observatory, University of California,
December 31, 1896.



THE EARTHQUAKE AT POMPEII, A.D. 62.





RELIEF MAP OF THE PACIFIC COAST, FROM A MODEL CONSTRUCTED BY PROFESSOR DAVIDSON.

CATALOGUE OF RECORDED EARTHQUAKE SHOCKS ON THE PACIFIC COAST, 1769 TO 1897.*

1769. April 11;

San Diego, Cal.—H. H. B.

1769. July 28; VI?

Four violent shocks in the Los Angeles region. Many more shocks were felt during the following week.—H. H. B.

1770.

At San Gabriel; which was called *El Valle de los Temblores* by Father Junipero Serró in a manuscript of 1778.—B. Ms.

1786. X.

Pavloff, Alaska, with volcanic eruption.—P.

1788.

Shumagin, Alaska, with tidal wave.—P.

1788. July 27;

Sannak Island, Alaska, overflowed by tidal wave.—P.

1788. July 27;

Ailiaska, Alaska, tidal wave.—P.

1790† X.

The Indians state that about eighty years before the shocks of 1872, March 26, in Inyo County, a similar earthquake occurred in the same region.—B. Ms.—*Alta*, April 6, 1872.

1796. May;

Bogoslov, Alaska, with eruption.—P.

1800. October 11 to October 31;

There were shocks from the eleventh to the thirty-first of October, sometimes six in a day, the most severe on the eighteenth, at San Juan Bautista.—H. H. B. Shocks October 11; another October 18,

* The Roman numerals I to X placed next after the dates represent the intensities on the Rossi-Forel scale as nearly as I have been able to assign them after a careful reading of the original accounts. These data are, of course, only approximate.

"at supper-time," and another at about 11 p. m. of the same day.—
J. B. T., *Register*.

1800. November 22;

A shock in Southern California.—H. H. B.

1802.

Unalashka, Alaska.—P.

1803. April;

San Gabriel, Cal.—T. H. H.

1803. May 25; VIII.

An earthquake damaged the Mission Church at San Diego slightly.—
—H. H. B.

1806. March 24, midnight; VIII.

The church walls at Santa Barbara were cracked.—B. Ms. T. H. H. mentions a shock in March, with no date.

1808. From June 21 to July 17; VIII.

There were twenty-one shocks at the Presidio of San Francisco.—
Trask, *Register*, p. 7.—H. H. B. and T. H. H. say eighteen. Adob walls were seriously damaged.—B. Ms. The first translator of Argüello's communication to the Governor raised the number eighteen to twenty-one, and all the rest have repeated the error.—H. H. B.

1812. X.

Atka, Alaska.—P.

1812. May; VIII +.

Southern California was subject to nearly continuous shocks for four and one-half months. Four days seldom elapsed without at least one shock. The inhabitants abandoned their houses and lived out of doors.—Trask, *Register*, p. 7.

1812. September, October, or December? Sunday? IX.

Fatal earthquake. At San Juan Capistrano the church was destroyed, with loss of life (thirty to forty-five persons). The Mission Church at Santa Inez, near Santa Barbara, one hundred and seventy miles from San Juan Capistrano, was completely destroyed and some lives lost.—J. B. T., *Register*. A Spanish ship at anchor, thirty-eight miles from Santa Barbara, was injured by the shock.—J. B. T., *Register*. The year 1812 was ever after known as *el año de los temblores*.—H. H. B. See letter of Lieut. E. O. C. Ord, U. S. A. (November, 1849), in Tyson's Report, Geology of California, p. 125, where, however, it is called the shock of 1814. October 8, between 7 and 8 a. m., is the day of the great earthquake which destroyed the church of San Juan Capistrano, according to a careful article in the

San Francisco *Bulletin*, March 5, 1864. This date is often fixed in September or on December 8. The *Sundays* were: September 6, 13, 20, 27; October 4, 11, 18, 25; November 1, 8, 15, 22, 29; December 6, 13, 20, 27.

1812. October 8;

Shocks for forty days at San Juan Capistrano.—B. Ms.

1812. October 21; IX.

Specially hard shock at San Juan Capistrano.—B. Ms.

1812. December 8; VIII. ?

From San Diego to Purisima; most severe at San Juan Capistrano. It is not clear that it was felt at either San Diego or at San Luis Rey. At San Gabriel the church was badly cracked and lost the top of the tower.—H. H. B.

1812. December 21; VIII. ?

At San Fernando the church received serious damages. At San Buenaventura, three heavy shocks before January 1. At Santa Barbara, a long series of shocks, beginning on the 21st and lasting several months.—H. H. B.

Santa Inez; two shocks, fifteen minutes apart, beginning at 10 a. m.

At Purisima (IX), at 10.30 a. m., December 21, the earth shook for four minutes so violently that it was difficult to stand. Half an hour later another more violent shock. A succession of light shocks this day and the next.—H. H. B.

P. Gil reported that there was a huge earthquake wave at sea. A stick with a pendant ball was set up at the Mission (Santa Barbara), and the ball vibrated continually for eight days, and later, at intervals for fifteen days. A ship at Refugio (IX) was carried up a cañon by the wave and returned to sea.—H. H. B.

Several asphaltum springs formed in the mountains and tulares; gaps in the Sierra; the "shore volcano" has more openings, and another is reported behind the Sierra de los Pinos.—H. H. B. [? ?]

1812.

San Francisco. Señora Juana Briones relates that in 1812 the earthquakes were so severe as to cause tidal waves which covered the ground where the plaza now is.—(Communicated by J. R. Jarboe, Esq.)

1813 or 1815. IX.

John Gilroy says an earthquake shook down all the buildings "in the region" (probably Santa Clara Valley) in one of these years.—B. Ms.

1815. January 18;

Five shocks at Santa Barbara.—H. H. B.

1815. January 30;

More shocks at Santa Barbara.—H. H. B.

1815. July 8, 9;

Six shocks at Santa Barbara.—H. H. B.

1817. April; X.

Umnak, Alaska.—P.

1818.

Makughin, Alaska.—P.

1818. VIII.

The church of Santa Clara was damaged.—T. H. H. "I think there is no authority for such a statement."—H. H. B., vol. 14, p. 377. A new Mission church had been contemplated in 1818. It is said that the old church was so badly injured by an earthquake in 1822 that it was best to take it down; and that a new church (now standing) was built in 1825-6. "For various reasons [which are given] I suppose nothing of the kind to have occurred. As a mere conjecture, it may be that after the church was completed, or nearly so, in 1818 it was damaged by an earthquake, and not fully repaired until 1822."—H. H. B., vol. 14, p. 602.

1821. January 1;

A severe shock at San Buenaventura and San Luis Rey, Cal.—H. H. B.

1824.

There are newspaper accounts of earthquakes in 1824.—H. H. B.

1826. June;

Unalashka, Alaska. Two shocks.—P.

1827. June;

Copper Island, Alaska.—P.

1829. September;

Several very severe shocks of earthquake were experienced in San Francisco, Cal.—*Annals of San Francisco*.

1830. VIII.

The church of San Luis Obispo was injured.—T. H. H.

1833. June 29; "13h. 40m. Os.," II.

Fort Nisqually, Washington.—P.

1836. April 2; X.

Pribyloff Islands, Alaska.—P.

1836. April 25; 5 a. m.

Monterey, Cal.—H. H. B.

1836. August; X.

Pribyloff Islands, Alaska.—P.

1836. June 9 and 10;

Severe shocks from Monterey northward.—H. H. B.

1836. VIII.

An earthquake comparable with the shock of 1868, October 21, was felt in the same region of country; great fissures were made in the earth, and the shocks continued for a month.—B. Ms.

1838. June and July; VIII.

Shocks at San Francisco, San José, Santa Clara, and Monterey, Cal.—H. H. B. Very severe in the harbor of San Francisco.—Verbal account of Don José Thompson.

1839. ?; shortly after 12 m.; IX.

Where Redwood City now is. Destructive. Adobe walls seven feet thick were cracked from top to bottom. The earth was cracked in many places, and one immense fissure extended from Lone Mountain (?) to the Mission San José.—B. Ms.—San Francisco *Call*, December 21, 1879.

1839. ?; VIII.

A very severe earthquake in San Francisco, Cal.—*Annals of San Francisco*.

1840. January 16-18; IX.

An earthquake and tidal wave at Santa Cruz. The church tower overthrown.—H. H. B.

1841. May 12; 9 p. m.; III.

A very short, slight shock at Monterey, Cal.—Duflot de Mofras, *Exploration de l' Oregon*.—R. M.

1841. July 3; 2h. 7m. p. m.; VII.

A shock at Monterey, Cal. Felt at sea.—Duflot de Mofras, *Exploration de l' Oregon*.—R. M.

1841.

Violent eruptions of Mt. Raynier, Oregon.—Perrey. [?]

1841. Summer; III.

Monterey, Cal. "The shocks of one hundred and twenty earthquakes were felt during two successive months of . . . summer. The average, however, of two earthquakes a day is not so frightful as it looks, the shocks being seldom severe, and often so slight as to escape the notice of the uninitiated stranger."—Simpson's *Journey Round the World*, vol. I, p. 344.

1842. September 28;

Eruption of Mt. St. Helens, Oregon.—Perrey. [?]

1842. November 23;

Eruption of Mt. St. Helens.—Perrey. (1843?) [?]

1842.

Eruption of Mt. Baker, W. T.—Perrey. [?]

1843. June 23; 3:30 p. m.; VIII? or more severe?

Very severe earthquake in California, which extended to Mexico.—Perrey.

1843. November 23;

Eruption of Mt. Raynier.—Perrey. (See 1842, November 23, and 1841.) [?]

1843.

Eruption of Mt. Baker, Oregon.—Perrey. [?]

1846-52; exact date not given.

In Oregon City, on Rock Creek, near Portland, Oregon, explosions like those of a cannon were heard for nearly the whole of a day. At first these were about half an hour apart; then they came nearer together, until at last they were no further apart than one minute or so; finally they died away. The water in Rock Creek did not run for three days.—Verbal account of Geo. J. Ainsworth, Esq.

1847. VI.

St. Paul's Island, Alaska.—P.

1848. January 4; III.

Slight shock at Los Angeles.—B. Ms.

1849. September 16; evening.

At Santa Isabel, between San Diego and the mouth of the Rio Gila.—Perrey.

1849. September 22; 3 p. m.

Twelve miles from Curisco Creek, in the desert between Santa Isabel and the Gila.—Perrey.

1850-1854.

"A Recent Volcano in Plumas County, Cal." by Dr. H. W. Harkness. Dr. Harkness describes his visit to a spot near the borders of Lassen and Plumas counties, directly across the northern end of Snag Lake (Lake Anna), twelve miles east of Lassen's Butte, and gives his own observations, showing a recent eruption, together with the evidence of other persons, all going to prove an active eruption about 1851.—*Proc. Cal. Acad. Sci.*, vol. 5, pp. 408-412.

1850. January 16; 11h., 2h. a. m. ? p. m.?

San Francisco, three shocks.—Perrey.

1850. February 15;

Several shocks, San Francisco, Cal.—Perrey.

1850. March 21; III.

A light shock in San José, Cal.—J. B. T.—Perrey.

1850. May 13;

San Francisco and San José; also slight eruption of Mauna Loa.—J. B. T. Perrey says: "In March and then May 12 and 13, six shocks in San José and San Francisco during eruption of Mauna Loa."

1850. June 28; III.

A light shock in San Francisco, Cal.—J. B. T.—Perrey.

1850. August 4; V.

Stockton and Sacramento, smart shocks.—J. B. T.—Perrey.

1850. August 15;

San Diego, Cal., and on the Gila.—Perrey.

1850. September 14; V.

Smart shock in San Francisco and San José.—J. B. T.—Perrey.

1851. March;

Several shocks in this month in California.—Perrey.

1851. April;

Shocks in California during April.—Perrey.

1851. May 13;

San Francisco and Salinas.—Perrey.

1851. May 15; 8:10 a. m.; VII.

San Francisco.—T. T.—J. B. T.—8:20 a. m.—Perrey. Coincident with an eruption of Mauna Loa. Severe shock, lasting about half a minute, felt by shipping in the harbor. Bottles were thrown from shelves to the floor.—B. Ms. Perrey says three shocks, in *Mém. Cour.*, vol. 8, p. 28.

1851. May 17; III.

A slight shock in San Francisco, Cal.—J. B. T.—Perrey.

1851. May 28; III.

A slight shock on the Salinas, Cal.—J. B. T.—Perrey.

1851. June 13; V.

Smart shock in San Francisco, San Luis Obispo; and San Fernando, Cal.—J. B. T.—Perrey.

1851. November 12; 7 p. m.; V.

San Francisco, Cal.—Perrey. Severe.—B. Ms.

1851. November 13; 7 p. m.

San Francisco, motion of the waters in the bay.—Perrey.

1851. November 15; 2 a. m.

San Francisco, Cal.—Perrey.

1851. November 15; 10 p. m.

San Francisco.—Perrey. Also, T. T.

1851. November 26;

Coast of California from $+37^{\circ}$ to $+40^{\circ}$ latitude, eleven shocks.—Perrey.

1851. December 2;

A shock at Downieville, Sierra County, Cal.—J. B. T.—Perrey.

1851. December 26; 7 and 8:10 p. m.

Two light vibrations in San Francisco.—T. T. "One shock in the morning, one at 20 minutes before 10 at night, and one at 35 minutes past 11."—B. Ms. Three shocks: "The first quite severe, at about 3 o'clock (a. m. ?); next about 10 (p. m. ?); last about noon."—B. Ms.—*Alta*, December 26, 1851. During the past two years the direction of the shocks has been invariably from north to south.—B. Ms.—*Alta*, December 28, 1851.

1851. December 30; 3 a. m.

San Francisco.—Perrey. (See December 26.)

1851. December 31; 3 a. m.; 9:35 a. m.; 11:40 a. m.?

Three shocks at San Francisco.—Perrey. (See December 26.)

1851. December 31; V.

Smart shock at Downieville, Sierra County, Cal.—J. B. T.

1852. April 12; midnight.

San Diego, Cal.—Perrey.

1852. October 26;

Eleven shocks at San Simeon; an equal number at Los Angeles and San Gabriel. Felt also at San Luis Obispo, San Diego, and Colorado River. During the next six days all the southern part of California shaken at short intervals.—Perrey. (See November 26.)

1852. November 9; VIII or IX?

Violent shock at Fort Yuma. The shocks continued almost daily for many months. The first shock threw down a portion of Chimney Peak and opened fissures and cracks in the clay desert bordering the Colorado. A small mud volcano was found in an active state

about forty miles southwest of the post.—Report of Exp. for Pacific Railroad, vol. V., p. 115. See Hittell's Resources, p. 44.

1852. November 20;

In Southern California, beginning of a series of thirty-two shocks.—Perrey.

1852. November 22; 11 p. m.; VIII.

Severe shock eight miles southeast of San Francisco. Next morning a fissure half a mile wide and three hundred yards long was discovered, through which the waters of Lake Merced were flowing to the sea.—B. Ms.—*Alta*, November 27, 1852; also November 28.

1852. November 23; a little before midnight.

Shock in California, accompanied by thunder and lightning.—Perrey.

1852. November 24;

San Francisco, Cal. Perrey says the waters of Lake Merced disappeared. (See November 22.)

1852. November 26; (October 26?)

Eleven strong shocks at San Simeon, Los Angeles, and San Gabriel, Cal.—J. B. T.—Perrey says November 20 was the beginning of a series of thirty-two shocks in Southern California.

1852. November 27-30; IX.

Continued shocks disturbing an area of over three hundred miles square, extending east from San Luis Obispo to the Colorado River, and north to San Diego.—J. B. T. The shocks opened fissures at least thirty miles long in Lockwood Valley.—Verbal account of J. De B. Shorb, Esq.

1852. November 29; about noon; IX.

San Diego. Shock lasted about two minutes. "The earth seemed to vibrate to and fro some five or six inches." This shock was followed by lighter ones about sunrise, for several days.—B. Ms.

1852. November 29; 12:20 p. m.

Fort Yuma and San Diego.—Perrey.

1852. December 5; about 11 p. m.

Fort Yuma.—Perrey.

1852. December 17; V.

Two smart shocks at San Luis Obispo, Cal.—J. B. T.—Perrey.

1852. December;

During the month of December the southern and middle portions of California were much disturbed, and the effects were felt as far north as the thirty-seventh parallel. The shocks continued into the month of January, and were noticed until the fifth of this month on the San Joaquin.—J. B. T.—Perrey.

- 1852. December 26;**
Los Angeles, Cal.—Perrey.
- 1852.**
Fort Yuma. Eruption of a mud-volcano in the Colorado Desert. —
Perrey, *Mém. Cour.* 13, p. 19.
- 1853. January 1;**
San Gabriel.—B. Ms.
- 1853. January 2; IV.**
Moderate shock in San Francisco, Bodega, and Shasta City, Cal.—
J. B. T.—Perrey.
- 1853. January 5;**
San Joaquin; Corte Madera.—J. B. T.—Perrey.
- 1853. January 10;**
At Captain Dana's rancho, San Luis Obispo County, Cal.—B. Ms.
Alta, February 24, 1853.
- 1853. January 29;**
Santa Barbara, Cal.—Perrey.
- 1853. January;**
Shocks at San Luis Obispo, Cal.; also at Mariposa and San Francisco.
—Perrey.
- 1853. February 1; 1 p. m.; VIII.**
Violent shocks at San Simeon, San Luis Obispo County. Houses
were injured.—B. Ms.—*Alta*, February 24, 1853.
- 1853. February 14;**
San Luis Obispo.—J. B. T.—Perrey.
- 1853. March 1; V.**
Smart shock at San Francisco, San Luis Obispo, and Santa Barbara.
—J. B. T.—Perrey.
- 1853. April 24; III.**
Light shock at Humboldt Bay, Cal.—J. B. T.—Perrey.
- 1853. April 25; 26?; III.**
Three light shocks at Weaverville, Trinity County, Cal.—J. B. T.—
April 26.—Perrey. April 26.—B. Ms.
- 1853. June 2; at night.**
San Francisco, Cal.—B. Ms.—Perrey.
- 1853. June 2;**
Two smart shocks in the plains of the San Joaquin.—J. B. T.—
Perrey.

1853. July 12; III.

A light shock in Yreka, Siskiyou County, Cal.—J. B. T.—Perrey.

1853. July 12;

San Joaquin, Cal.—Perrey.

1853. September 2¹ or 3²;

Four shocks in Salinas and San Joaquin Plains.—J. B. T.—September 2¹?—Perrey. September 2²?—B. Ms.

1853. October 2;

San Joaquin, Cal.—Perrey. [Possibly this refers to September 2, q. v.—E. S. H.]

1853. October 23; VIII.

Three heavy shocks at Humboldt Bay, Cal.—J. B. T. At Eureka it is said the houses rolled like ships at sea and the wharf sank 4 feet.—B. Ms. Also at Acapulco, Mexico, and Peru.—Perrey.

1853. October 25; III.

A light shock at Humboldt Bay, Cal.—J. B. T.—Perrey.

1853. November 16; III.

A light shock at San José, Cal.—J. B. T.—Perrey.

1853. November 18; III.

Slight shock at San José.—B. Ms.

1853. November 20; 11 p. m.

San Francisco, Cal. More than thirty shocks since January 1.—Perrey.

1853. November 21;

A shock at San Francisco, Cal.—J. B. T.—Perrey.

1853. November 23;

Shasta, Cal.—Perrey.

1853. November 25;

San Francisco.—Perrey.

1853. December 11;

San Francisco and Mission Dolores.—J. B. T.—Perrey.

1853. December 23; III.

A light shock at Shasta City, Cal.—J. B. T.—Perrey.

1853. December;

Many shocks in Fort Yuma region; geysers formed.—B. Ms.—Also *Second Annual Report of State Mineralogist of California*, 1880-2, p. 233.

1853;

Perrey refers to eruptions of Hood, St. Helens, Mt. Baker, etc.—
Am. J. Sc., 2d series, v. 20, p. 297, September, 1855.

1854. IV.

Kaviak, Alaska.—P.

1854. January 3; V.

Two smart shocks at Mariposa and Shasta, Cal.—J. B. T.

1854. January 9; 3:30 a. m.

San Francisco, Cal.—T. T.—Perrey.

1854. February 5; 6:50 p. m.

San Francisco, Cal.—B. Ms.

1854. March 2; III.

A light shock in San Francisco, Cal.—J. B. T.—Perrey.

1854. March, about the 16th;

San Francisco.—Perrey.

1854. March 16; night.

San Francisco, Cal.—Perrey.

1854. March 20;

Stockton, Cal.—J. B. T.—Perrey.

1854. February-April;

Mountain of St. Helens, Oregon, was in eruption about February—
April.—Perrey. [?]

1854. March;

St. Helens, Oregon, in eruption.—Perrey. [?]

1854. April 10;

Two shocks at San Francisco, Cal., 10.30 a. m. and 10.45 a. m., the
second the severest.—B. Ms.—*Alta*, April 11, 1854. More violent
at Point Lobos.—Perrey.

1854. April 10;

Mt. St. Helens still in eruption.—Perrey. [?]

1854. April 14; 10-11 a. m.

Two shocks, San Francisco, Cal.—Perrey.

1854. April 20;

Santa Barbara, Cal.—Perrey.

1854. April 29; III.

A light shock at Santa Barbara, Cal.—J. B. T.—Perrey.

1854. May 3; 5h. 10m.; V.

Three severe shocks at Santa Barbara, Cal.—J. B. T.

1854. May 18;

Santa Barbara, Cal.—Perrey.

1854. May 23;

A shock at Crescent City, Humboldt County, Cal.—J. B. T. And San Francisco, Cal.—Perrey. 11h. 20m. p. m.—Perrey.

1854. May 29;

Santa Barbara, Cal.—Perrey.

1854. May 31; 4:50 a. m.

Three shocks at Santa Barbara, Cal.—J. B. T.—Perrey.

1854. June 26;

Two light shocks in Placer County, Cal.—J. B. T.—Perrey.

1854. July 10;

Shock at Georgetown, El Dorado County, Cal.—J. B. T.—Perrey.

1854. July 14;

Shock at Georgetown, El Dorado County, Cal.—J. B. T.—Perrey.

1854. August;

Smoke [?] on Mount Hood.—Perrey.

1854. September 14; III.

A light shock at Nevada (Cal.?)—J. B. T.—Perrey.

1854. October 2;

Humboldt, Cal.—Perrey.

1854. October 21; III.

A light shock at Monterey, Cal.—J. B. T.—Perrey.

1854. October 21; 7:30 p. m.; VI.

San Francisco, Cal.—T. T. 7.35 p. m.—Perrey. "The severest since 1851."—B. Ms., *San Francisco Daily Herald*, October 22, 1854.

1854. October 26; V.

Smart shocks at San Francisco and Benicia, Cal., followed by a sea wave.—J. B. T.—Perrey.

1854. November 1?;

Angel Island.—B. Ms., *Alta*, November 1, 1854; *Nevada Journal*, November 10. A calm sea and no wind at first; then water rose several feet with high waves, lasting half an hour.

1854. November 11; 4½h. p. m.

San Francisco.—Perrey.

1854. December 23;

Violent shock occurred in Japan. In the harbor of Simoda the water was agitated so that its depth varied between 8 and 40 feet. The waves were transmitted across the Pacific and registered on the tide gauges of the United States Coast Survey at San Francisco, Astoria, and San Diego. The velocity of the sea wave was: Simoda to San Francisco, 368 miles per hour, 5.966 miles per minute; Simoda to San Diego, 355 miles per hour.—A. D. Bache, in *Am. Jour. Sci.*—Perrey.

1855. January 2; just before 10 a. m.; III.

Two slight vibrations five seconds apart. San Francisco, Cal.—B. Ms.—*San Francisco Golden Era*, January 6, 1855.

1855. January 13; 18h. 30m.; V.

Smart shock at San Benito and San Miguel, Cal. It was also felt at San Luis Obispo.—J. B. T.

1855. January 14; 10 p. m.; V.

Along ninety-four miles of the coast of California.—Perrey.

1855. January 24; 22h.

A heavy shock, lasting seven seconds, was felt at Downieville, Sierra County, Cal. This shock was quite severe at Gibsonville on the north, at Forest City and Minnesota, in Sierra County; and at Orleans Flat and Eureka, Humboldt County; in Nevada County; at Georgetown and Nashville in El Dorado County on the south; and at Keystone Ranch, in Yuba County, on the west.—J. B. T.

1855. February 5; 10 a. m.; III.

A light shock at Wolf Creek, and the northeast part of Nevada County, Cal.—J. B. T.

1855. April 7; 6 p. m.; III.

A light shock at Gibbs Ferry, Trinity County, and as far north as Calahan's Ranch, at the head of Scott's Valley, Siskiyou County.—J. B. T.

1855. June 9; 5 a. m.; III.

Fort Yuma; slight shock. *Report of explorations for railroad near the 32d parallel*, Appendix I, p. 9, vol. VII.

1855. June 25; 14h.; V.

Smart shock at Santa Barbara, and north to the Valley of Santa Maria.—J. B. T.

1855. July 10; 9h. 30m.; III.

A light shock at Georgetown, El Dorado County, Cal.—J. B. T.

1855. July 10; 20h. 15m.; VIII.

Severe shock at Los Angeles. Four shocks were felt in about twelve seconds; two unusually heavy sea waves rolled in at Point San Juan, just after the last shock.—J. B. T. This shock was accompanied by rain.—B. Ms. Bells at San Gabriel Mission Church thrown down.—B. Ms. See August 12.

1855. July 13; III.

Slight shock at Gibsonville, Sierra County, Cal.—*S. F. Daily Herald*, July 23, 1855.

1855. August 12; 9:30 a. m.; III.

A light shock at Georgetown, Cal.; four light shocks at Georgetown, from July 10 to August 12, dates not recorded.—J. B. T.

1855. August 26; 1 p. m.

Sonoma County; Petaluma.—B. Ms.—*Sacramento Union*, September 8, 1855.

1855. August 27; 3 p. m.; VI.

Violent shock, Sonoma County, Cal.—*Sacramento Union*, September 8, 1855. Also violent at Petaluma and at Mission San Francisco de Solano.

1855. August 28;

San Francisco, Cal.—B. Ms.

1855. October 5; 7½h. p. m.

San Francisco.—Perrey.

1855. October 21; 19h. 45m.; V.

Smart shock in San Francisco. Much commotion in the water of the bay a few minutes preceding the shock.—J. B. T.

1855. October 27; 3 p. m.; III and IV?

A light shock in the Valley of Clear Lake; a light shock at Downieville, Sierra County; more severe shock at Goodyear's Bar.—J. B. T.

1855. December 5; 11:20 a. m.

A shock at Humboldt Bay, Cal.—J. B. T.

1855. December 11; 4h.; VI.

San Francisco; quite severe at Mission Dolores.—J. B. T.

1855. December 21; 11h. 20m. a. m.

Humboldt Bay, Cal.—Perrey.

1856. January 2; 10h. 15m.; VII.

Smart shock at San Francisco, Cal.—J. B. T. Light shock at 10 a. m.—T. T. "Severe."—B. Ms.—*San Francisco Daily Herald*, January 3, 1856. Goods were shaken from the shelves.—B. Ms. 9 a. m. and 10 a. m.—Perrey.

1856. January 10; 5 a. m.

Slight shock; and another at about 8 a. m. [at San Francisco?]. This was very severe at Los Angeles and throughout the southern part of the State (VI).—B. Ms.

1856. January 21; 16h.; V.

Smart shock in San Francisco, Cal.—J. B. T.

1856. January 23; 4 p. m.

Mission [Dolores?] Cal.—Perrey.

1856. January 28; 3h.; V.

Smart shock at Petaluma, Sonoma County, Cal.—J. B. T.—Perrey.

1856. January 29; 0h. 45m.; III.

Slight shock at San Francisco, Mission Dolores.—J. B. T.—Perrey.

1856. January 31; 4 p. m.

[San Francisco?].—Perrey.

1856. February 15; 5h. 25m. a. m., in S. F. (See 1858, November 26.)

In San Francisco (VIII), severe shock of eight seconds; a previous shock at 2.08 a. m. Heavy shock at Monterey, Cal. (V), 5.20 a. m. Shock at Bodega, Cal. (IV). Twenty-two vessels off the coast, from San Pedro to southern Oregon, felt no shock. Shock at Santa Rosá (IV?) and no further N.; light shock at Stockton, and no further E.; shocks at San José.—Trask, *Register*, p. 15.—Perrey. Two shocks in San Francisco, one at 2.15 a. m.; one at 5.23 a. m., lasting twelve seconds. Not felt at Sacramento, slight at Stockton; severe at San José (VI), hardest at Oakland (VII).—B. Ms. Severe at S. F., 5.35 a. m.—T. T. The water in the Bay of S. F. rose, maintained its level for five minutes, and then sank two feet below its ordinary stage.—B. Ms.

1856. March 15;

San Francisco.—Perrey.

1856. March 24; 22h. 20m.; III.

A slight shock was felt at Canal Gulch, Siskiyou County; also at Yreka.—J. B. T.—Perrey.

1856. March 30; 8:30 p. m.

S. F., Cal.—B. Ms.—*Sacramento Union*, April 2, 1856.—Perrey.

1856. March 31; 12:30 a. m.

S. F., Cal.—B. Ms.—*Sacramento Union*, April 2, 1856.

1856. March 31; 1:30 a. m.

S. F., Cal.—*S. F. Daily Herald*, April 1, 1856.

1856. April 6; 23h. 30m.; V.

Smart shock at Los Angeles, El Monte, Cal.—J. B. T.—Perrey.

- 1856. April 14;**
Los Angeles, Cal.—Perrey.
- 1856. May 2; 6h. 10m.; V.**
Severe shock at Los Angeles.—J. B. T.
- 1856. May 9; night.**
Los Angeles.—B. Ms.
- 1856. May 10; 21h. 10m.; III.**
Light shock at San Francisco.—J. B. T.; and Monterey.—Perrey.
- 1856. August 2; 5h. 20m.; III and IV?**
A light shock in San Francisco, Cal.; more severe at Stockton.—J. B. T.—Perrey.
- 1856. August 27; 21h. 15m.; IV.**
Moderate shock, twice repeated, from the west, at Mission San Juan, Monterey, Santa Cruz.—J. B. T. Another strong shock [where?] in the night of August 29.—Perrey.
- 1856. September 6; 3h.; V.**
Smart shock at Santa Cruz, Cal.—J. B. T.—Perrey.
- 1856. September 20; 23h. 30m.; VII.**
Very severe shock in San Diego County, Cal.—J. B. T.—Perrey.
- 1856. September 22; evening; III.**
San Diego, Cal.; light shock.—Perrey.
- 1856. September 25; 11:30 p. m.**
San Diego County.—B. Ms.—S. F. *Bulletin*, October 18, 1856.
- 1856. September 28;**
Slight shocks in parts of Southern California.—B. Ms.
- 1856. September 29;**
Slight shocks in parts of Southern California.—B. Ms.
- 1856. October 1;**
Slight shocks in parts of Southern California.—B. Ms.
- 1856. October 18; "morning"; III.**
Slight shock at S. F., Cal.—B. Ms.—*Sacramento Union*, October 22, 1856.
- 1856. November 12; 4h.; V.**
Smart shock, Humboldt Bay, Cal. Another shock was reported, but no date given.—J. B. T.—Perrey.
- 1856. December 26;**
Port Townsend, Washington.—Perrey.—P.

1856. December 7; about 10 p. m.

Foot of Clear Lake, Lake County, Cal.—B. Ms.—S. F. *Bulletin*, September 3, 1859. This shock was not felt at Big Valley, thirteen miles away.—B. Ms.

1856? December? VII.

Very severe in San Diego, Cal.—Verbal account of Don José Thompson.

1856. In the fall; IX.

Tulare County. The line of the shock "was marked by a fracture of the earth's surface, continuing in one uniform direction for a distance of some two hundred miles."—B. Ms.—Barton, *History of Tulare County*, p. 11.

1857. January 8; 11:20 p. m.; also January 9; VIII? IX?

Heavy earthquakes in California. All the houses in Santa Barbara were damaged.—Perrey.

At Ft. Tejon this shock was more severe than the shocks of 1812.—B. Ms.—*Nevada Journal*, May 8, 1857. Two persons killed by being buried in the ruins of a house.—B. Ms.—*Los Angeles Express*, December 4, 1875? [1857?]. Visalia, Tulare County, it was difficult to stand erect; tree tops waved several feet to and fro; it was equally severe at places within fifty miles north and south.

1857. January 8; 6 a. m., 9 a. m., 10 a. m.

Three shocks at Santa Barbara; and in the afternoon two slight shocks and one severe one; 8.30 a. m., Los Angeles; 8.15 a. m., San Francisco; 7 a. m., Monterey; 7.30 a. m., Sacramento.—Perrey. San Francisco, 8 a. m.—T. T. At Los Angeles, five or six shocks during the day, and within eight days about twenty shocks.—B. Ms.—*Sacramento Union*, February 5, 1857.

1857. January 8 and 9;

California. Dr. Trask shows that the velocity of the earth wave was: San Francisco-Sacramento, 6.6 miles per minute; San Francisco-Stockton, 6.5 miles per minute; San Francisco-Tejon, 6.0 miles per minute; San Francisco-San Diego, 7.0 miles per minute. Or, on the average, 6.2 miles per minute, or 545.6 feet per second.—*Amer. Jour. Sci.*, vol. 25, p. 146.

1857. January 9; 8:20 a. m.

At Stockton, and Benson's Ferry on the Mokelumne, several shocks on the night 8-9, the principal one at 8.15 a. m.; 8.30 a. m., very severe at Sacramento; 7 a. m., at Los Angeles and Monterey.—S. F. *Bulletin*, January 9, 1857. San José, Cal.—*Sacramento Union*, September 20, 1858.

1857. January 9;

Ft. Tejon, the earth opened in cracks twenty miles long; buildings and chimneys were thrown down; beds of streams changed.—B. Ms.—*Los Angeles County History*, p. 545.

857. January 9; IX.

Fort Tejon. On ninth January, 1857, an earthquake shook the earth from Fort Yuma (IX) to Sacramento (VI). It was most severe at Fort Tejon (IX). A loud rumbling accompanied the shock at Tejon, San Bernardino, Visalia (IX) and Mojave Valley. The waters of the Mokelumne River were thrown upon the banks, so as to leave the bed bare in one place. The current of Kern River was turned up stream, and the water ran four feet deep over the bank. The water of Tulare Lake (IX) was thrown upon its shores; and the Los Angeles River (IX) was flung out of its bed. Some of the artesian wells in Santa Clara Valley ceased to run, and in other places the water increased. Near San Fernando, a large stream of water ran from the mountains, where there was no water before. In San Diego and San Fernando, several houses were thrown down (IX), at San Buenaventura (IX) the roof of the Mission Church fell in. Several new springs were formed near Santa Barbara. In the San Gabriel Valley the earth opened several miles long; and in one place the river left its bed and followed the new opening. A large fissure was made in the western part of San Bernardino. At Fort Tejon nearly all buildings were thrown down, large trees overthrown, and the earth opened in a fissure twenty feet wide and forty miles long; the sides then came together with such violence that a ridge was formed ten feet wide and several feet high. At Reed's ranch, near Fort Tejon, a house was thrown down and a woman in it killed.—B. Ms.—Hittell's *Resources*, pp. 42-43. At San Benito (VIII or IX?), 15 or 20 miles N. W. of San Benito, Dr. Canfield's Diary says 3 shocks, the first about sunrise [which was at 7.23 a. m.], lasting not over 5 seconds, accompanied by noise. The second about 8 a. m., "very much more violent—pieces of mortar fell from the walls—I was almost thrown from my seat—this lasted for a minute or two [!] and I then went out of doors, when the oscillation returned and lasted perhaps a minute, but was quite gentle." The direction was S. to N. A person lying down reported a shock at 10 a. m., which was not felt by persons in motion (II).

857. January 16; V.

Severe shock at Los Angeles.—B. Ms. 5 p. m.—Perrey.

857. January 17; night.

Two shocks; January 18, 8 a. m.; [at Los Angeles?—Perrey.

857. January 18; 9 a. m.; III.

A light shock at Martinez and Benicia, Cal.—J. B. T. Monterey.—Perrey.

857. January 20; Sh. 30m. a. m.; V.

Strong shock at Santa Cruz and Mission San Juan, Cal.—J. B. T.

1857. January 20; VI.

Severe shock, Ft. Tejon.—B. Ms.—*Los Angeles County History*, p. 545.

1857. January 20; 3:30 p. m.

Mission San Juan.—Perrey.

1857. January 21; III.

15 or 20 miles N. W. of San Benito. About 7h. 20m. a. m.? p. m.? a slight shock lasting a few seconds.—Dr. Canfield's Diary.

1857. January 21; evening; V.

Smart shock at Mariposa, Cal.—J. B. T. 11 p. m.—Perrey.

1857. February 5; 7 p. m.

San Francisco, Cal.—J. B. T.—T. T. 6.55 p. m. Two shocks at S. F., Oakland, and Stockton, Cal.—Perrey.

1857. March 5; about 7 p. m.

Two short shocks in San Francisco, Cal.—Perrey.

1857. March 14; 15h.; V.

Severe shocks at Santa Barbara and Montecito.—J. B. T.

1857. March 23; 12:27 a. m.; III.

A light shock in San Francisco, Cal.—J. B. T.

1857. April 1; VI.

15 or 20 miles N. W. of San Benito. About 3.35 a. m. a severe shock lasting about 8 sec.—Dr. Canfield's Diary.

1857. April 24?.

A shock was recently felt at San Gabriel and San José, Cal.—Perrey.

1857. May 2; morning.

Two shocks at Los Angeles.—B. Ms.

1857. May 3; 22h.; VI.

Smart shock at Los Angeles and El Monte, Cal.—J. B. T. "Violent shock."—Perrey.

1857. May 23;

Slight shock at Los Angeles (III). Severe shock at Fort Tejon (VI).—J. B. T. "Four shocks at Los Angeles."—B. Ms.

1857. June 14; VI.

Severe shock at Humboldt Bay, Cal. Several severe shocks at the Penal Island (Carmen), Gulf of Cal.—J. B. T.

1857. July 5; 7h.; VI.

Severe shock at San Francisco, Cal.—J. B. T.

1857. August 8; 11h.; V.

Smart shock at Rabbit Creek, Sierra County, Cal.—J. B. T.

1857. August 29; VI.

Severe shock at Tejon Reserve, Cal.—J. B. T.

1857. September 2; 19h. 45m.; III.

Slight shock at San Francisco, Sacramento, Marysville, Nevada, San Juan, Downieville, and Camptonville, Cal.—J. B. T.

1857. September 7;

San Francisco.—Perrey.

1857. September 7;

Violent earthquake in California?? quoted from meteorological observations in 71st report Univ. of N. Y., p. 359, by Perrey, who, however, thinks the date doubtful.

1857. September 14; 2 p. m.; III.

A slight shock in San Francisco, Cal.—J. B. T. At 2.15.—T. T.

1857. September;

Birch Bay, Washington.—P.

1857. October 19; 18h. 30m.; VI.

Severe shock at San Francisco, Cal.—J. B. T. 6.15 p. m.—T. T.

1857. October 20; 12h. 30m.; 12h. 35m.; 13h. 15m.; III?

Three shocks felt at San Francisco and San José, but not in Oakland; the last the most severe.—J. B. T. Light shock 1.20 a. m.—T. T.

1857. November 2; 6:25 p. m.; III.

S. F., Cal., in the night several light shocks.—Perrey.

1857. November 3; 1:16 a. m. and 3 a. m.

S. F., Cal.—Perrey.

1857. November 8; 3:45 a. m.

San Francisco, Oakland, and Bodega, Cal.—J. B. T.

1857. November 9; 0:45 a. m.

San Francisco, Cal.—T. T.

1857. November 9; 2:30 a. m.

San Francisco, Cal.—T. T.

1857. November 15; a little after 6 p. m.

San José.—B. Ms.

1857. December 23; 7 a. m.; III.

A light shock in San Francisco, Cal.—J. B. T.

1857. December 24; 5:40 a. m.?
Four shocks; S. F., Cal.—Perrey.

1857. December 30; 5:40 a. m.
S. F., Cal.—Perrey.

1857.
"Accounts from Fort Tejon report frequent shocks in that section of the country." Dr. Trask does not mention them in his notes on earthquakes in California during 1857.—Perrey.

1858. January 1 or 2;
San Francisco.—Perrey.

1858. January 18; 9 p. m.
S. F., Cal.—S. F. D.

1858. February 10; V.
Smart shock at Kanaka Flat, Sierra County, Cal.—J. B. T.

1858. February 15; 4h. 20m.; IV.
A light shock in San Francisco, and also in San Mateo County, Cal.
J. B. T.—Perrey.

1858. August 18; 10:45 p. m.; VI.
Two shocks, first light, second heavy enough to waken sleepers, Sonoma County.—B. Ms. 10.55 p. m.—*S. F. Directory—Sacramento Union*, August 23, 1858. 10.55 and 10.58 p. m., S. F., Cal.—T. T. "No shock so severe as this in S. F. since February 15, 1856."—B. Ms.

1858. August 19; 22h. 10m.; III.
A light shock in San Francisco.—J. B. T.

1858. September 2; V.
Smart shock at Santa Barbara, Cal.—J. B. T.

1858. September 3; 0h. 40m.; V.
Strong shock at San José and Santa Cruz, Cal.—J. B. T.—Perrey.

1858. September 12; 19h. 40m.; V.
Smart shock at San Francisco, Cal.—J. B. T. Lasting 15 seconds.—Perrey.

1858. September 26; 1h. 26m.
A light shock in San Francisco.—J. B. T.—Perrey.

1858. September ?;
San José and elsewhere. In San José more violent than the shock of January 9, 1857.—B. Ms.—*Sacramento Union*, September 20, 1858.

1858. November 26; 12:35 a. m.; VII.

San Francisco. "A violent earthquake was experienced in the city this morning at twenty-five minutes before one o'clock. It consisted of two shocks, separated by an interval of a few seconds, and lasting altogether about half a minute. It is considered to have been nearly as violent as the great shock of February, 1856, and to have lasted much longer. A great deal of alarm was occasioned in some of the larger structures of the city, particularly in the Montgomery block, and in the Rassette House and other extensive hotels. A number of buildings were vacated temporarily. At Musical Hall, where the Independent National Guard were having a ball, the shock was not noticed on the dancing floor, though the building was very much shaken. In the Merchants' Exchange building, opposite the Custom House, some large cracks were made, and a portion of the cornice in the U. S. District Court-room was shaken down. At the City Hall some small pieces of plastering were shaken off, but no serious injury was done; nor, indeed, have we heard of any damage in the city. At the Union Hotel, adjoining the City Hall, the window-blinds were observed to flap violently against the windows, and it was thought by persons in Merchant Street that the building would fall, so violently was it rocked. In many portions of the city bells were rung and crockery rattled."—B. Ms.—*S. F. Bulletin*, November 26, 1858.

1858. November 26; VIII.

San José. "The earthquake was more severely felt at San José than any that has before occurred there. Every family had dishes, glassware, or clocks broken by falling off the shelves or tables. Almost every grocery store had bottles, etc., thrown off the shelves and broken. Every brick, adobe, or concrete building was cracked or injured in some way, or had the plastering broken off. Some plastering was broken off the City Hall. The Jail and Sheriff's office, a two-story brick building, was damaged considerably by the cracking and falling of the plastering. The new Baptist church had the front walls cracked in several places. A new brick building, only one story high, eighteen by twenty feet in size, and very firmly built, was cracked through the center, and had the plastering shaken off. Mr. Minor's concrete building had two corners and a part of the cornice shaken off, damaging it to the extent of about five hundred dollars. Our informant says: "Mr. J. Lewis' large clock was stopped at just eighteen minutes and twenty-two seconds before one o'clock, which must have been the exact time of the commencement of the trembling. He looked at his watch at the conclusion of the shock, when it was just eighteen minutes to one—which would make the duration of the earthquake just twenty-two seconds, if the watch and clock kept the same time. The undulations were from the north to the south,

accompanied by a rumbling noise."—B. Ms.—*S. F. Bulletin*, November 27, 1858.

1858. November 26; 0:35 a. m.; VII.

Two shocks, San Francisco, Cal.—T. T. 0h. 24m. a heavy shock at San Francisco and Oakland.—J. B. T. Nearly every brick building in San José was injured. The shock at San José was twenty-two seconds long, and began at 0h. 42m.—B. Ms.—Perrey. This shock was not felt at Stockton, Sacramento, nor Marysville.—J. B. T. N. B.—This shock was a Santa Clara Valley earthquake.

1858. December 6; 2 p. m.

Mariposa, Cal.—Perrey.

1859. January 25; 20h. 20m.; VI.

Severe shock in Trinity and Shasta Counties; at Weaverville, Shasta, and Horsetown.—J. B. T.

1859. March 21; 5h. 20m. a. m.

San Diego, Cal.—Perrey.

1859. March 25; VI.

Fourteen shocks, one very severe, at San Felipe, Santa Clara County, Cal.—B. Ms.

1859. March;

Dr. Mogencraft reports an eruption in northern part of Shasta County.—Perrey. [?]

1859. April 4; 13h.; VI.

Severe shock at San José, Cal.—J. B. T.

1859. April 27; 7:30 p. m.

San Francisco, Cal., two shocks.—Perrey.

1859. August 8;

San José.—*Sacramento Union*, August 15, 1859.

1859. August 10; about 9:30 p. m.; V.

Heavy shock at San José; after several minutes another slighter.—B. Ms.—*Sacramento Union*, August 15, 1859.

1859. August 10; 22h. 35m.; V.

Smart shock in S. F.—J. B. T.—S. F. D.

1859. August 15; August 17.

Eruption of Mt. Hood, Oregon.—Perrey. [?]

1859. August 29; 10:30 p. m.

Three distinct shocks in Mariposa County, Cal.—B. Ms.—*Alta*, September 10, 1859.

1859. August;

Big Valley, Lake County, Cal.—B. Ms.—*S. F. Bulletin*, September 3, 1859.—The shocks were not felt a few miles off. (See 1856, December.)

1859. September 9; 9:30 a. m.

Two distinct shocks. Petaluma, Cal.—B. Ms.—*Sacramento Union*, September 15, 1859. Slight shock, S. F., Cal. (IV?).—B. Ms.

1859. September 22; a. m.; VI.

Severe shock, S. F., Cal.—S. F. D.

1859. September 24; 3 a. m.; IV.

Slight shock at Half Moon Bay.—B. Ms.—*Sacramento Union*, September 28, 1859. Waters of the bay receded fifteen feet and returned suddenly.

1859. September 24; 5:45 a. m.

San Francisco, Cal.—T. T.

1859. September 26; 6h. 10m.; V.

Smart shock in San Francisco, Cal.—J. B. T.

1859. October 5; 0:16 p. m.; VII.

Severe shock at San Francisco, Cal.—T. T. 13h. 8m.; strong shock, S. F., Cal.—J. B. T.—Perrey.—The severest since 1856, February 15.

1859. October 18; 6 a. m. (See September 24).

S. F.; at Half Moon Bay the water left the bay for several seconds.—Perrey.

1859. November 19; 3 a. m.; IV.

Slight shock, S. F., Cal.—B. Ms.—*Sacramento Union*, November 22, 1859.

1859. November 22;

Mt. Baker in full activity.—Perrey. [?]

1859. November 25;

San Francisco, Cal.—Perrey.

1859. November 27; evening.

Two shocks, San Francisco, Cal.—Perrey.

1859. November 27; 19h. 15m.; IV.

A light shock in San Francisco, Cal.—J. B. T.

1859. December 1; 0h. 50m.; V.

Smart shock in San Francisco, Cal. Felt at Oakland and Benicia.—J. B. T.—Perrey.

1859. December 1; 14h. 10m.; V.

Several successive shocks were felt at San Bernardino; several of them were quite heavy.—J. B. T. 2.10 p. m.—Perrey.

1859. December 6; evening; IV.

Slight shock at S. F., Cal.—S. F. D.

1859. December 11; 9 a. m.; V.

Smart shock at San José.—B. Ms.—*Sacramento Union*, December 12, 1859.

1859. December 24; 0:54 a. m.

San Francisco, Cal.—T. T.

1859. December;

Eruption of Mt. Baker.—Perrey. [?]

1860. January 1; 8:43 p. m.; III.

Light shock at S. F., Cal.—Perrey.

1860. January 26-27; night.

Los Angeles, Cal.—Perrey.

1860. February 9; a few minutes before 1 o'clock.

S. F., Cal.—B. Ms.—*Sacramento Union*, February 10, 1860.

1860. March 15; 11h.; VII.

Violent shock at Sacramento. The wave passed through the counties of Placer, Nevada, El Dorado, and Plumas. The earthquake extended to the eastern base of the Sierra Nevada. At Carson City it occurred at 10h. 45m. and was very violent.—J. B. T.

1860. March 26; VI.

Los Angeles and Southern California, severe.—B. Ms.

1860. March 27; VI.

Severe shock in Los Angeles and vicinity.—J. B. T.

1860. April 2; 8 p. m.; VI.

Two severe shocks at San Juan, Monterey County, Cal.—B. Ms.—*Sacramento Union*, April 7, 1860.

1860. April 5; 1 a. m.

Several shocks in S. F., Cal.—Perrey.

1860. April 16; 7:30 p. m.

San Francisco, Fort Tejon, Santa Barbara.—B. Ms.—*Sacramento Union*, May 1, 1860.

7 p. m. Severe shocks at S. F., Cal. (VI).—Perrey. April 17? About this time shocks during several hours at Washoe, Nev.—Perrey.

1860. April 19;

Several shocks, S. F., Cal.—Perrey.

1860. April 26;

Eruption of Mt. Baker.—Perrey. [?]

1860. May 7;

Port Townsend, W. T.—Perrey.—P.

1860. May 25; about 6 a. m.

Two shocks at S. F., Cal.—B. Ms.—*Sacramento Union*, May 28, 1860.

1860. June 1; evening.

Mariposa.—B. Ms.—*Sacramento Union*, June 9, 1860.

1860. September 23; 10 a. m.

S. F., Cal.—B. Ms.—*Sacramento Union*, September 26, 1860.

1860. September 23; about 9 p. m.; VI.

Severe shock at Martinez.—B. Ms.—*Alta*, October 1, 1860.

1860. September 30; 10 a. m.

S. F., Cal.—Perrey.

1860. November 12; V.

Smart shock at Humboldt Bay, Cal.—J. B. T. Felt in various parts of the country, also.—B. Ms. *Alta*, November 24, 1860.

1860. November 24; 1:30 a. m.

S. F., Cal.—Perrey.

1860. December 21; 6h. 30m.; I?

Repeated slight vibrations, extending over a period of half an hour, noticeable only by the vibrations of the mercury in the barometer. S. F., Cal.—J. B. T. The next day a violent earthquake at Santiago de Chile.—Milne's *Earthquakes*, p. 331. [Probably no connection between these events.]

1861. January 12; about 1 a. m.; VI.

Two severe shocks in Trinity County, Cal.—B. Ms. *Sacramento Union*, January 29, 1861.

1861. January 27; 8 a. m.

Butte County, Cal.—B. Ms. *Sacramento Union*, February 4 and February 12, 1861. (Supposed to be an explosion of gunpowder, or of a meteor, or the rumbling of an avalanche. Heard also in Sierra County.)

1861. February 2; 1:30 a. m.

San Francisco, Cal.—Perrey.

1861. March 23; ? a. m.; V.

Quite severe at S. F., Cal.—B. Ms.—*Sacramento Union*, March 25, 1861.

1861. March ?

Tejon, Cal.—B. Ms.

1861. April 29; 4:10 a. m. ? p. m. ? III.

Slight shock at S. F., Cal.—B. Ms.—*Sacramento Union*, May 2, 1861.

1861. April 29; 9:25 p. m.; V.

Smart shock at Mendocino, Cal.—B. Ms.—*Sacramento Union*, May 11, 1861.

1861. May 4; p. m.; III.

Slight shock in the neighborhood of San Francisco. During this week the tides were unusually low.—Perrey.

1861. June 13; 5:25 a. m.; III.

Slight shock at S. F., Cal.—B. Ms.—*Sacramento Union*, June 15, 1861.

1861. July 2;

Alameda, Cal.—B. Ms.—*Sacramento Union*, July 8, 1861.

1861. July 3; 4:11 p. m.

Severe shock, followed by two light shocks, at San Francisco, Cal.—T. T. For several days light shocks were felt in and near S. F.—J. B. T.

A light shock in San Francisco (IV?), but *very heavy, indeed*, at Doherty's Ranch, in Amador Valley, near where Livermore now is (IX?).—Verbal account of R. C. Hopkins. Adobe houses seriously injured; men in the fields were thrown down.—Hittell's *Resources*, p. 43. Stockton, also.—B. Ms.

1861. July 3; 8 a. m.; July 4 and 5, at night; July 7, at night.

Slight shocks in Alameda, Cal.—B. Ms.—*Sacramento Union*, July 15, 1861.

1861. July 4?; 16h. 11m.

Severe shock of earthquake occurred at San Francisco. It consisted of three distinct waves, following each other in very rapid succession. More severe in the San Ramon Valley, east of the city. It opened a large fissure in the earth, and a new spring of water. For several days after there were light shocks. J. B. T.—Perrey.

1861. September 16; 2 a. m.

Violent earthquake at Sierra Valley, Nevada County, Cal.—B. Ms.—*Sacramento Union*, September 30, 1861.

1861. October 26? November 26?

Humboldt, Cal.—B. Ms. *S. F. Bulletin*, December 2, 1861, gives the date as October 26; *Sacramento Union* gives November 26. The same shock is referred to by both papers.

1861. December 9;
Santa Catalina Island.—B. Ms.
1862. January 21; about 5 a. m.
Stockton.—B. Ms.—*Sacramento Union*, January 25, 1862.
1862. March;
Tejon, Cal.—B. Ms.
1862. May 27; VI.
Severe shock in Southern California, San Diego, Temecula, and Anaheim.—B. Ms.
1862. May 27 to June 5;
Shocks nearly every day.—B. Ms. [In Southern California??
E. S. H.]
1862. June 7;
Los Angeles.—B. Ms.
1862. June 18;
San Diego, Cal.—B. Ms.
1862. June 14;
San Diego, Cal.—B. Ms.
1862. July 2; about 5 p. m.; VI.
A severe shock at La Porte, Sierra County, Cal.—B. Ms.—*S. F. Bulletin*, July 11, 1862.
1862. September 28; 7-8 a. m.
In the *Echo du Pacifique* of October 1 two shocks are reported.—
Perrey.
1862. September 29; 15h. 5m.; VI.
A very smart shock at San Francisco. Felt also at Petaluma.—J.
B. T.
1862. October 21; VI.
Violent shock at San Diego, Cal. Seven shocks since May 28.—B. Ms.
1862. December 20? 27?; about 5 a. m.
S. F. and Oakland, Cal.—Perrey.
1862. December 28; 20h. 19m.; V.
Smart shock in San Francisco, Cal.—J. B. T. 5.30 a. m.—T. T.
Thunder at 2 a. m.—B. Ms.
1862. December 29; III.
Slight shock at San Francisco.—S. F. D.

1863. January 17; about midnight.
S. F., Cal.—Perrey.

1863. January 25; 2h. 20m. p. m.; VI.
A severe shock at San Diego, Cal.—J. B. T.—B. Ms.—*Alta*, February 11, 1863.

1863. January 25; 5h. 20m.; VI.
Severe shock in San Diego, Cal.—J. B. T.

1863. February 1; 16h. 1m.
A very smart shock at the Mission San Juan, Monterey County (V?). At Gilroys, twelve miles east of the Mission, the shock was fifteen minutes later. The shock was not felt at Monterey, twelve miles west of the Mission.—J. B. T.

1863. February 6; 4 p. m.
New Gilroy, twelve miles northwest of San Juan, at 4.15 p. m.; San Juan, Monterey County, 4 p. m.—B. Ms.—*Alta*, February 11, 1863.

1863. March 18; about 2 a. m.; VI.
A severe shock in San Francisco, Cal.—S. F. D. (not noted by T. T. 2 a. m.).

1863. June ?; V.
A smart shock at San Francisco, Cal.—J. B. T.

1863. About June 27; 1:11 p. m.
San Diego.—B. Ms.—*Alta*, July 7, 1863.

1863. July 15; 6:30-8:30?; V.
Two strong shocks at San José, Cal.—Perrey.

1863. July 15; 10h. 19m.; V.
Smart shock in San Francisco, Cal.—J. B. T.

1863. July 16;
San José; Santa Clara.—B. Ms.

1863. July 24; about 10 a. m.; V.
A severe shock at S. F., Cal.—S. F. D.

1863. July 31; about 10 a. m.
Strong shock at S. F., Cal.—Perrey.

1863. August 1; 10h. 48m. p. m., and 11h. 6m. p. m.
Two shocks at San Francisco.—J. B. T.

1863. August 2; 11:15 p. m.; V.
Three severe shocks at S. F., Cal.—S. F. D. (not noted by T. T.).

1863. October 18;

Yuba City, Sutter County, Cal.—B. Ms.—*S. F. Bulletin*, October 22, 1863.

1863. December 19; 2:38 p. m.; VIII?

Severe shock at S. F., Cal., followed a few seconds later by one more severe. Probably the severest shock since 1855.—B. Ms.—[1856?].

1863. December 19; 2:45 p. m.; VII.

Very severe shock at San José and Santa Clara.—B. Ms.—*Alta*, December 20, 1863.

1863. December 23; 2:40 p. m.; V.

Strong shock, 5-6s., in S. F., and San José, Cal.—Perrey.

1863. December 30; about 3 a. m.; V.

Strong shock in S. F., Cal.—Perrey. Several shocks.—S. F. D.

1864. February 26; 0h. 40m., and 2h. 10m., 5h. 47m.; VI.

Shocks in San Francisco, Visalia, San José, and Santa Clara.—J. B. T. Severe at Santa Cruz.—B. Ms. Severe in S. F.—B. Ms.—Perrey. Very severe at Santa Cruz (VI).—Mr. Sawin's Diary.

1864. March 5; Sh. 49m.

A shock of considerable violence at San Francisco, Santa Rosa, Santa Cruz (V), Stockton, Petaluma, Santa Clara (VI), and San José (VI). At the last named place the shock was most violent and lasted about two minutes. Very severe at Visalia (VI).—J. B. T. Light shock at S. F., 8:50 a. m.—T. T.

1864. March 5; V.

Santa Cruz. Door bell rung.—Mr. Sawin's Diary.

1864. 8:30 a. m. (Date?)

Tuolumne, Cal.—B. Ms.—*S. F. Bulletin*, March 10, 1864.

1864. March 10; 14h. 8m.; IV.

A light shock at San Francisco.—J. B. T. 16h. 30m., a second shock.—J. B. T.

1864. March 11; 9:15 a. m.; III.

Slight shock at S. F., Cal.—S. F. D.

1864. March 20; 23h. 45m.; III.

A light shock in San Francisco.—J. B. T.

1864. March 22; 13h.; V.

Smart shock at Stockton, Cal.—J. B. T.—S. F., Santa Clara—Perrey.

1864. May 20; 18h. 1m. [6h. 1m. ?]

Slight shock at San Francisco, Cal.; 18h. 10m. severe shock at Stockton (V); 18h. 57m. severe shock at Napa (V); 18h. very severe at Sacramento (VI).—J. B. T.

1864. May 20; 5:56 p. m.

Light shock at San Francisco, Cal.—T. T. Five or six shocks were reported about 6 p. m., *very severe* [?].—*Mining and Scientific Press*. S. F. D.

1864. June 6; 11h. 7m.; III.

A light shock in San Francisco.—J. B. T.

1864. June 22; 20h. 53m.; V.

Smart shock at San Francisco, Cal.—J. B. T.—Perrey.

1864. July 5; 20h. 3m.; IV.

Moderate shock at San Francisco, Cal.; four vibrations.—J. B. T.

1864. July 18; Sh. 20m. p. m.

Near Los Angeles, Cal.—Perrey.

1864. July 21; 2h. 7m.; V.

Smart shock in San Francisco.—J. B. T. Several shocks, July 21.—S. F. D.

1864. July 21; 22h. 40m. 38s.; VI.

A very smart shock in San Francisco, San José, and Stockton; twelve minutes later in Los Angeles, but not very heavy.—J. B. T. *Not felt at Sacramento.*—Perrey.

1864. July 25; 23h. 56m.

Los Angeles, Cal.—J. B. T.

1864. August 1.

San Francisco, San José, Sacramento, Stockton, and Los Angeles. Perrey.

1864. August 15; 9h. 53m. p. m.; V.

Fort Miller, Fresno County, Cal.; strong shocks.—Perrey.

1864. August 17; 22h. 39m.; IV.

A light shock at Nevada, Cal., and vicinity.—J. B. T.—Perrey.

1864. August 18; 5h. 18m.; VI.

Very strong, Grass Valley, Cal., and Nevada.—J. B. T. Marysville, Yuba.—Perrey.

1864. September 6; 10h. 3m.

San Francisco, Cal.—J. B. T.—Perrey.

1864. September 20; 11h. 0m.

San José and S. F., Cal.—J. B. T. 10.45 a. m.—S. F. D.

1864. September 27; 10h. 32m.; V.

Strong shock, Mission San Juan, Monterey County, Cal.—J. B. T.
Also at Watsonville.—Perrey.

1864. September 29; 11:20 a. m., ? p. m. ?

San Francisco.—Perrey.

1864. September 30; 10:30 a. m.

San Francisco.—Perrey.

1864. October 6; 21h. 9m.; V.

Smart shock at San Francisco, Cal.—J. B. T.—Perrey.

1864. October 14; 1h. 8m.; V.

Two heavy shocks at Mission San Juan.—J. B. T.

1864. October 14; 10h. 25m.

Heavy shock at Mission San Juan.—J. B. T.

1864. October 18; at night.

San Juan; two shocks.—Perrey.

1864. October 21; 3h. a. m.; V.

Strong shock at San Juan Bautista.—Perrey.

1864. October 27; about 10 p. m.; IV.

San Francisco, Cal. (Several light shocks.)—Perrey.

1864. October 29; night.

Victoria (Vancouver). Severest shock on record [?], lasting fifteen seconds. Felt also at New Westminster.—Perrey. (VI) at Victoria.—P.

1864. December 11; 20h. 52m. [Sh. 52m. ?]

At San Francisco and San José; at the last place one minute later and more severe.—J. B. T. 9 p. m.—S. F. D.

1864. December 18; V.

Strong shock at Watsonville, Santa Cruz County, Cal.—Perrey.

1865. January 2;

Ukiah, Mendocino County, Cal.—B. Ms.

1865. January 9; 7h.; V.

Smart shock in Santa Rosa, Sonoma County, Cal.—J. B. T.—Fuchs.
Perrey.

1865. January 19; Sh. 8m.; III.

A light shock in San Francisco.—J. B. T.

1865. February 4; 11 p. m.; V.

Strong shock in S. F., Cal.—Fuchs.

1865. February 7; to end of 1866.

It is the opinion of Fuchs (p. 10) that a period of earthquakes in San Francisco began on February 7 and lasted during the whole of the year 1866, and even into 1867. The greatest shock was 1865, October 8.

1865. February 7; 11 p. m.

San Francisco.—Perrey.

1865. February 8; 2 p. m.; V.

Strong shock in S. F., another at $6\frac{1}{2}$ p. m.—Fuchs.

1865. March 5; night.

Petaluma; the heaviest ever felt up to this time.—B. Ms.

1865. March 5; 8h. 45m.; IV.

A light shock at Visalia, Cal.—J. B. T.

1865. March 7; 11 $\frac{1}{2}$ p. m.; V.

Heavy shock in Napa City, followed one hour later by a lighter one.—Fuchs. Smart shock at San Francisco at 23h. [11h.?]—J. B. T.

1865. March 8; 6 a. m.; V.

Heavy shock at Napa City, and half an hour later another shock. In Santa Rosa, six shocks.—Fuchs. Smart shock in S. F., 6h. 20m. J. B. T.

1865. March 19;

San Francisco.—Perrey.

1865. March 24; 7:30 a. m.; IV;

Rather severe shock in S. F., Cal.—Fuchs.

1865. March 30; 7h. 28m.; V.

Very smart shock at San Francisco, Cal.—J. B. T.—Perrey.

1865. April 15; 0h. 40m.; VI.

Severe shock at San Diego, Cal.—J. B. T.

1865. April 18; 13h. 31m.; IV and V.

Light shock at San Francisco, Angel Island, and Oakland (IV). Severe at San Juan, Monterey County (V).—J. B. T.

1865. April 26; 3:55 p. m.; V.

Quite a severe shock in S. F.—*Mining and Scientific Press*. Heavy shocks in many places in California, all from E. to W.—Fuchs.—Perrey. Two shocks, S. F., Cal.—S. F. D.

1865. April 27; 15h. 56m.

Shock at San Francisco, Cal.—J. B. T.

1865. May 24; 3h. 21m.; V.

Smart shock at San Francisco, San Juan, and Santa Cruz. At the first place, a single movement; at the second, two waves.—J. B. T.—Perrey.—Fuchs. Light shock at 3.30 a. m.—T. T. Remarkably heavy in Southern California (VII?).—B. Ms.

1865. June 12; ?

Several shocks at Victoria, Vancouver Island.—Fuchs.—P.

1865. June 14; 12m.; III.

Slight shock at S. F., Cal.—S. F. D.

1865. August 25; 9 p. m.; VI.

Heavy shock at Vancouver Island, lasting two minutes; later two more shocks.—Fuchs. (IV) at Victoria.—P.

1865. August 29; 5 a. m.

Shock in S. F., Cal., from southeast to northwest.—Fuchs.—Perrey.

1865. September 21;

Eruption at Mt. Hood.—Perrey. (Doubtful.)

1865. September 22; V.

Smart shock at Yreka, Cal.—J. B. T.

1865. September 23;

Mt. Hood in eruption from September 23 to October 8, certainly.—B. Ms. [?]

1865. October 1; 7 a. m.; IX.

Heavy shock at Eureka, Cal.—Fuchs. Which destroyed all the brick houses.—Perrey.

1865. October 1; 9h. 15m.; VI or more severe.

Very smart shock at Fort Humboldt, Cal.—J. B. T.

1865. October 3; V.

Heavy shock at Eureka, Humboldt County, Cal.—B. Ms.

1865. October 5; ?

Shock in S. F., Cal.—Fuchs.—Perrey.

1865. October 8; 12h. 46m.

Very severe shock at San Francisco, San José, Stockton, Santa Cruz, Sacramento, etc. Most severe shock since the annexation of the territory, and it was followed by a condition of continuous vibration, which lasted for about ten hours. J. B. T.—T. T. Yolo County.—B. Ms.

1865. October 8; 22h. 1m.

Light shock at San Francisco, San José, Stockton, Santa Cruz, Sacramento, etc.—J. B. T. Another at 23h. 50m.—J. B. T.

1865. October 8; IX; (Sunday).

San Francisco. The first shock was felt at sixteen minutes before one o'clock p. m., and lasted perhaps five seconds. It was almost instantly followed by a heavier shock, which continued for ten seconds or more. The vibrations appeared to be east and west, or northeast and southwest. There was nothing in the weather or in the condition of the atmosphere during the previous week to foretell the earthquake. On October 8, in the evening, there were two or three slight additional shocks. The chief damages to buildings were to Popper's building, Third and Mission streets, the City Hall, the old Merchants' Exchange, corner Battery and Washington streets. The latter building was completely ruined. The California Engine Company's House, Market and Sansome streets, was severely injured and rendered unfit for occupancy. The chimney in the rear of the Lick House was shaken down. Stoddard's warehouse on Beale Street is said to have been thrown out of place several inches. On Third Street, from Market to Howard, the window glass was broken in many places. On Washington Street, also, the glass appears to have suffered from Dupont Street down to Montgomery. On the marshy lands in the vicinity of Howard and Seventh streets, lamp posts, water pipes and gas pipes were broken and thrown out of position. The ground on Howard Street, from Seventh north to Ninth, cracked open, leaving a fissure nearly an inch wide. Not one fatal accident has yet been heard of. The effect of the earthquake on the waters of Mission Bay and on Long Bridge was frightful. The shock was felt severely at San José. About ten feet of the wall of the jail was thrown down, and a portion of the wall of the Methodist church. The bell of the convent was tolled. At Santa Clara nearly all of the brick buildings in town were more or less injured. On the Santa Cruz Gap road chimneys were thrown down and the roads more or less obstructed by stones rolled down from the mountains. At Stockton the shock was very severe. At Visalia and Los Angeles the earthquake was not felt at all.—B. Ms.—*S. F. Bulletin*, October 9, 1865. A friend walking on W. side of Montgomery Street, S. F., near Bush, did not feel the shock at all.—E. S. H.

1865, October 8. The shock at Sacramento did no damage, although it was severe enough to cause many persons to feel nausea (VII).—B. Ms.—*S. F. Bulletin*, October 11, 1865.

1865, October 8. This shock was not felt in the slightest degree at Santa Barbara—at least not in the vicinity of the town.—B. Ms.—*S. F. Bulletin*, October 17, 1865.

1865, October 8. At New Almaden a large brick storehouse on the hill was nearly demolished. Several houses in the village were thrown down. The earth opened and closed again, throwing up great clouds of dust. Two miles out of San José, on the road to New Almaden, the new brick building of Mr. John W. Winters was materially damaged. A number of chimneys in different parts of the county were thrown down.—B. Ms.—*San José Patriot*, October 11; quoted in *S. F. Bulletin*, October 12, 1865.

1865, October 8. "The streams at McCartyville and Los Gatos have risen greatly since the earthquake, tapping the sources of the artesian wells in the Santa Clara Valley, many of which have ceased to run since the earthquake."—B. Ms.—*S. F. Bulletin*, October 31, 1865.

1865, October 8. At Mountain Charley's, on the Santa Cruz road, the earth opened in several places, and steam and water were thrown up through the cracks. At McCartyville or Saratoga the creek began to rise four hours after the great shock, and increased to about treble the usual quantity of water the creek discharges during the dry season.—B. Ms.—*S. F. Bulletin*, October 21, 1865.

1865. October 8; VIII.

At Fort Humboldt, on Sunday morning, October 8, 1865, at fifteen minutes past nine o'clock, there was a very severe earthquake. Fifteen chimneys will have to be completely rebuilt.—*S. F. Bulletin*, October 12, 1865.

1865. October 8; VIII or more severe.

Goose Lake, Siskiyou County, Cal. Waterspouts observed all over Goose Lake.—B. Ms.—*Yreka Union*, October 28, 1865.

1865. October 8;

Accounts given in Bancroft's Ms. as follows: *San Francisco Bulletin*, October 9, 12, 1865. *San Francisco Call*, October 10. *Gold Hill News*, October 12. *Sacramento Union*, October 10. Hittell's History of San Francisco, p. 354. Shocks felt at Petaluma, but no damage done (VII). *Petaluma Journal and Argus*, October 12. *San Francisco News Letter*, October 14. *S. F. Golden Era*, October 15. (Two articles), *S. F. Californian*, October 14. (In the interior), *S. F. Alta*, October 10, 11, 14, 16 and 17. *S. F. Alta*, October 9 and 10.

1865. October 8;

From Rowlandson the following is extracted: The shock was certainly felt one hundred miles north of S. F. and one hundred miles east. There is no report of any shock south of Monterey Bay. It is a singular fact that the shock was most severe at Santa

Cruz and along the lower part of the Pajaro River (IX). The center of disturbance was probably at the mouth of this river. Mt. Hood was in eruption, and Goose Lake was covered with waterspouts, and Rowlandson connects these with the S. F. disturbance. There was no shock felt at any distance from the coast, but boats a few miles from shore felt the shock.

1865. October 9; 10h. 34m.; IV.

Light shock in San Francisco, Cal.—J. B. T.

1865. October 9; 11h. 32m.; IV.

Light shock at San Francisco. After this shock the earth continued to vibrate for forty-eight hours.—J. B. T.

1865. October 12; 12:45 a. m.

S. F., and Santa Clara, Cal.—B. Ms.—*S. F. Bulletin*, October 13, 1865. Constant tremors in San Francisco.—Fuchs. This Santa Clara shock is stated to have been as heavy as the one felt between 10 and 11 o'clock, October 8.—See also Perrey.

1865. October 13; 2h. 5m.; V.

Smart shock at San Francisco, Oakland, Santa Clara, and Angel Island, Cal.—J. B. T.

1865. October 14, 15, 16; night and day.

Monterey—many shocks.—B. Ms.

1865. October 14; 23h. 45m.

San Francisco, Cal.—J. B. T.

1865. October 15; 3h. 40m.

San Francisco, Cal.—J. B. T. Santa Cruz; Santa Clara.—B. Ms.—Perrey.

1865. October 20; 7:55 p. m.

S. F., Cal.—Fuchs.—Perrey.

1865. October 27; 1 a. m.

Napa City, Cal.—Fuchs.

1865. November 24; 3:45 a. m.

Shocks in S. F. and in Santa Cruz County, Cal.—Fuchs. Smart shock at Watsonville, Santa Cruz County (V).—J. B. T.

1865. November 26; ?

At sea, between S. F. and Portland, an earthquake.—*Mining and Scientific Press*.

1865. December 7; 1h. 15m.; IV.

Light shock in San Francisco.—J. B. T.

1865. December 15; 9 p. m.; VII.

Heavy shock at Dry Creek, Mendocino County, Cal.; nine shocks, three being quite heavy.—*Mining and Scientific Press*.

1866. January 25; 10:32 a. m.

Slight shock in S. F., Cal. (IV). At 10h. 10m., heavy shock in Sonoma (V).—Fuchs. Another smart shock in S. F. at 10.40 (V).—Perrey.

1866. February 15; 8:45 a. m.

Slight shock in San José, Cal., followed at 9.10 by a shock covering a greater area.—Fuchs. At 8.57 a. m. two shocks at S. F., Cal.—B. Ms. Two shocks at Santa Clara.—Perrey.

1866. February 17; IX.

"The Klamath River, fifteen miles above the Jacksonville road, was suddenly raised, exposing its bed, while a hill on its bank sunk away to a level plain; on one side of the hill, where it separated from the mainland, it left an abrupt bluff. The river channel was immediately changed, the water running around where the hill had been standing. Bob Whittle and others witnessed the phenomenon, and gathered large quantities of fish that were left in the old bed when the water drained off."—B. Ms.—*Quincy Union*, March 10, 1866.—*Yreka Journal*.

1866. February 18; 4:05 p. m.

S. F., Cal.—Fuchs.—Perrey.

1866. March 26; 12:30 p. m.; IV.

Earthquake from east to west, in S. F., Stockton, Sacramento, San José, etc.—Fuchs. Two shocks.—S. F. D.

1866. March 26; V.

Quite a severe shock at Monterey.—B. Ms.

1866. March 26; 12:12 p. m. (noon); III.

Two slight shocks at S. F.—B. Ms.

1866. March 27;

Monterey.—B. Ms.

1866. March ?;

Monterey, Cal.—B. Ms.—*S. F. Golden Era*, March 25, 1866.

1866. April to November;

San José, Cal. An earthquake register, invented by W. F. Stewart, has noted nine distinct shocks in the past seven months. All the shocks were northeast and southwest.—*San José Mercury*, November 8, 1866.

1866. May 24; 9:05 a. m.
Sacramento.—B. Ms.

1866. May 27;
Pacheco, Contra Costa County, Cal.—B. Ms.

1866. May 30; 3:40 a. m.; V.
Heavy shock in S. F., Cal.—Fuchs. Also in Oakland.—B. Ms.—Perrey.

1866. June 5; 6:04 a. m.; IV or more severe.
Rather heavy shock at S. F., Cal.—Fuchs.—Perrey. Seven shocks.—B. Ms. About 4 a. m.—S. F. D.

1866. June;
Monterey, Cal.—B. Ms.—*S. F. Golden Era*, July 1, 1866.

1866. June;
? —B. Ms.—*Gold Hill News*, June 2, 1866.

1866. July 13; 11 p. m.
S. F., and interior towns.—S. F. D. [Probably same? as July 14.—E. S. H.]

1866. July 14; 10:30 p. m.; V.
Heavy shock in La Porte, Rowland Flat, St. Louis, and Port Wine, Sierra County, Cal.—Fuchs. Also Sacramento and Contra Costa County.—B. Ms. Also in S. F.—B. Ms. Heavy in Sacramento; light in S. F. and Stockton (IV).—Perrey.

1866. August 19; 12:40 a. m.
Shock in Oakland and San Francisco.—*Mining and Scientific Press*.

1866. August 23; 4 p. m.
S. F., Cal.—B. Ms.

1866. During the summer; V.
A severe sudden shock at Sulphur Bank, Clear Lake, Cal.—Verbal account of R. S. Floyd, Esq.

1866. September 5; morning.
La Porte, Rowland Flat, St. Louis, and Port Wine, Sierra County, Cal.—B. Ms. Perrey says 5 a. m.

1866. September 6;
Two shocks at S. F., Cal.—S. F. D.

1866. November;
San José, Cal.—B. Ms.—*S. F. Golden Era*, November 18, 1866.

1866. December; III.

Dalles, Oregon.—P.

1866. December 17; night.

Antioch, Contra Costa County, Cal.—B. Ms.

1866. December 18;

Pacheco, Contra Costa County, Cal.—B. Ms.

1866. December 19; 2:20 a. m.

Subterranean noises, accompanied by shocks, in San Francisco and Sacramento, Cal.—Fuchs.—Perrey. 3 a. m.—S. F. D.

1866. December 20; 4:15 p. m.

Antioch, Contra Costa County, Cal. Also a shock in the morning.
B. Ms.

1866. December ?

A smart shock at the Dalles, Oregon.—*Mining and Scientific Press*, Vol. 14, p. 46.

1867. January 8; daylight. [?] X.

Frightful earthquake at Fort Klamath, Oregon; the Klamath Lake fell six feet.—Fuchs. Two shocks, the second frightful. The air grew dark, ashes fell as thickly a snow in a storm.—B. Ms.—P. gives VIII (??).

EARTHQUAKE AT FORT KLAMATH.—The following letter is to the Oregon *Sentinel*, from Fort Klamath, dated January 8, 1867: Editor *Sentinel*: We have singular, if not serious news, to send by the express just leaving. This morning at daylight we were startled from our sleep by the precipitate shock of an earthquake, immediately followed by a noise as of distant thunder. But in a little while quiet reigned, and every one was conversing and laughing heartily at the singular phenomenon; but our countenances soon underwent a serious change, for it began to grow dark; the whole heavens were full of a very black smoke or cloud; the air had a sulphurous smell; and ashes of a brownish color fell as fast as I ever saw it snow. We had to use candles in the mess-room. Most of us went into breakfast, but had only got fairly into our seats, when, horror upon horror, the earth seemed rolling like waves upon the ocean; every one was thrown to the floor, only, on regaining their feet, to be placed in the same position again, accompanied with the rattling of dishes, the crashing of window glass, cracking of timber of buildings, and the screams of the frightened. You could not imagine a more perfect chaos. Some of us gained the door, and such a sight met our gaze as was probably never before beheld. The tall pines around the fort seemed lashing themselves into fury; the wagons in front of the

stable were engaged in a pitched battle; horses and cattle were lying crouched upon the ground, uttering the most pitiful moans; dogs were howling, and the unearthly cries of the Klamath Indians camped near the fort, completed the scene. The sutler's store was thrown about ninety feet from its former position. There were no lives lost, nor any serious accidents to any one. There is no very serious damage done to any of the buildings, all being log and frame houses, but I do not think there is a whole pane of glass left at the post. Most of us are of opinion that a volcano has broken loose near the Klamath marsh, as a continuous dark column of smoke is seen in that direction. There was but half an hour between the first and second shocks. The first was just perceptible. The second lasted, as near as can be judged from various opinions, from two to three minutes. Further particulars will be given by the next express.

L. TENNYSON, Quartermaster's Clerk.

Mr. Whitmore has just arrived from the agency, and reports that the lake (Klamath) has lowered about six feet, and is still falling. Crooked Creek, a stream between this place and the agency, is completely dried up.—B. Ms.—*S. F. Bulletin*, January 14, 1867.

1867. February 1; ?

Three shocks in San Diego, Cal.—Fuchs.—Perrey.

1867. April 12; 4:50 p. m.

Two shocks in San Francisco.—Fuchs.—Perrey says 5:50 p. m.

1867. August;

Lower Yukon, Alaska.—P.

1867. September 22; 5:35 p. m.

San Francisco, Cal.—Fuchs.

1867. November 30; VI.

Quincey, Plumas County, Cal. Severe shock.—B. Ms.

1867. December 1; 11:12 p. m.

Forest City, Cal.—Fuchs.—Perrey also. Nevada City, very heavy (VII).—B. Ms.

1868. January 2; 9 p. m.

Lake County.—B. Ms.—*Yolo County Hist.*, pp. 56-7.

1868. March 24; 11:22 a. m.; V.

Sharp shock, San Francisco, Cal.—*Mining and Scientific Press*. At 11:22 a. m., lasted six to ten seconds.—B. Ms.

1868. March 25;

Alameda County, Cal.—B. Ms.—*S. F. Bulletin*, March 26.

1868. March 28; about 11 p. m.

S. F., Cal.—S. F. D.

1868. March 29; about 9 p. m.

S. F., Cal.—S. F. D.

1868. About April 23;

Healdsburg, Cal.—*S. F. Bulletin*, May 7, 1868.

1868. April 29; 7:15 a. m.

Three distinct shocks, no damage done, Yreka, Cal.—B. Ms. The first experienced here; it was accompanied by a rumbling noise.—*S. F. Call*, April 30, 1868.

1868. May 7; 12 a. m.; V.

Severe shock at Healdsburg, Cal.—*S. F. Bulletin*, May 7, 1868.

1868. May 9; 11:30 p. m.

Calistoga, Napa County.—B. Ms.—*Alta*, May 11, 1868.

1868. May 18;

Three hundred miles west of San Francisco, in lat. $44^{\circ} 7'$ N. and long. $139^{\circ} 7'$, a submarine earthquake.—Perrey.—*Mém. Cour.* 22, p. 80.

1868. May 24; 9 p. m.

Two shocks in Sacramento, Cal.—Fuchs. Not felt in S. F.; violent in the State of Nevada.—Perrey.

1868. May 26; 10:37 p. m.

San Francisco, Cal.—Fuchs.—Perrey. Two shocks.—B. Ms.

1868. May 27; about 2 a. m.; IV.

S. F., Cal., light shock.—B. Ms.

1868. May 29; 9 p. m.

Three shocks, Lassen County, Cal.; first at 9 p. m.; two others in the course of fifteen minutes.—B. Ms.—*S. F. Bulletin*, June 12, 1868. About 9 p. m., series of shocks in interior of California and in Nevada; but not at S. F., nor north of a line from Sacramento to Ft. Churchill; felt in Sacramento.—B. Ms.

1868. May 30;

Severe earthquake at Mukelteo and the Tulalip Reservation, W. T.—*Bulletin*, June 2, 1868.—P.

1868. May; IX?

A severe earthquake (not felt in Northern or Central California) opened a long fissure in the earth at Dos Palmas, S. P. R. R.—H. Ms.—Editorial *S. F. Bulletin*, March 29, 1872.

1868. June 1.

San Diego? Earthquake wave on Pacific Coast.—B. Ms.—*S. F. Bulletin*, June 13, 1868.

1868. June 2; 9:30 a. m.; VII.

Very severe, Downieville and Forest City.—*S. F. Bulletin*, June 10, 1868.

1868. July 24; III.

Slight shock at S. F., Cal.—*Appleton's Annual Cyclopædia*, 1868.

1868. July 24; 6:30 p. m.; VII.

Severe shock in Tulare County, Cal.—*S. F. Bulletin*, July 25, 1868.

1868. August 2;

Los Angeles (several shocks).—B. Ms.

1868. August 9; about 10 p. m.

S. F., Cal.—S. F. D.

1868. August 13;

The earthquake at Arica, Peru, on this date, produced tidal waves felt all through the Pacific, and registered at S. F. and San Diego. Velocity of the sea-wave 369 (or 348) miles per hour.—J. E. Hilgard in *Amer. Jour. Sci.*, vi. p. 77. Tidal wave sixty feet high in Southern California; San Pedro Bay.—R. A. Proctor, in *Nature*.

1868. August 24;

Santa Cruz, Cal.—*S. F. Bulletin*, September 3, 1868.

1868. August 24; 11:30 a. m.

S. F., Cal.—S. F. D.

1868. August 28; about 1 a. m.

S. F., Cal.—S. F. D.

1868. August 31; VI or more severe.

Severe shock at Santa Cruz, Cal., lasting ten or fifteen seconds.—B. Ms.

1868. August-September 28;

It is the opinion of Fuchs (p. 10) that a period of earthquakes in the Sierra Nevadas began early in August, 1868. On September 4, 5, 6, there was a great earthquake with more than five hundred shocks, and the period lasted till September 28.

1868. September 3-28; IX.

"Kern River, Inyo County, Cal., September 3, during the night frequent rumbling noises and tremulous motion of the earth. September 4, 8 a. m., severe shock; from 8 to 9 a. m., forty-one dis-

tinct shocks. During the remainder of the day the shocks continued at intervals of five to ten minutes: light shocks continued until the morning of the 6th of September, when the party moved their camp. Up to this time there had been about five hundred shocks. September 6-11, one or two shocks every hour. September 17, 18, 19, about one shock every hour. September 20, 21, 22, much more frequent and severe; then the frequency and violence abated, but continued at intervals of an hour or so up to the time they left on the 28th of September."—J. E. Clayton, M. E., in *Proceedings of the California Academy of Sciences*, vol. IV, part 1. See also Perrey.—*Mém. Cour.* 23, p. 64.

1868. September 3, etc.:

Not felt at Independence, Inyo County.—B. Ms.

1868. September 13, 14, 15:

A correspondent of the *Sacramento Union*, writing from Owens Lake, gives an interesting account of a succession of earthquakes that took place in that region, among the mountains, on the 13, 14, 15 of September. The shocks were severe enough to rattle down rocks from the mountains into the valleys and to excite great alarm among the few inhabitants. About the same time there was an earthquake in Alpine County which was quite severe, showing that the commotion must have extended over hundreds of miles.—*Proceedings of the California Academy of Sciences*.

1868. September 4-17:

Inyo County, Cal., September 4, two shocks; forty shocks in one hour at Lone Pine; September 12, one shock; September 14, two shocks; September 17, one shock; September 11-12, three hundred shocks; the sky was very full of smoke.—B. Ms.

1868. September 17:

Two shocks at Nevada City, Cal.—B. Ms.

1868. September 19; 9 a. m.

Two heavy shocks at Alpine, Cal. The air became dark, and mountains one-half mile distant could not be seen. A 5 p. m. other shocks.—B. Ms.

1868. September 26; 12:40 a. m.; VIII.

Ukiah, Mendocino County, Cal., severe shock; tumbling furniture about.—B. Ms.

1868. October:

Near head of Kern River. [S. F. *Bulletin*, October 17, 1868, says: "There is quite a phenomenon on the Sierra Nevadas, at the head of Kern River. The earth has been shaking for more than two weeks—almost a constant shake. It shakes the rocks down from the mountain, and makes the earth wave like the sea." * * *]

1868. October 3; 12:40 a. m.

Very severe shock in Ukiah Valley, Cal.—B. Ms.—*Alta*, October 7, 1868.

1868. October 6;

Silver Mountain, Cal.—*Appleton's Annual Cyclopædia*, 1868.—Perrey.

1868. October 21; IX.

The great earthquake at San Francisco, Cal. The first shock was at 7h. 33½ m. a. m. Its direction was northerly and southerly [more correctly S. 30° W. to N. 30° E.—J. R. J.]. Its duration was forty-two seconds. The second shock came at 9.23 a. m., lasting five seconds. Lighter and briefer tremors occurred at intervals of about half an hour, till 12.15 p. m. The first shock was most severely felt on the eastern side of the city, on the made land between Montgomery Street and the bay. On the solid land no serious damage was done to any well constructed house. Window panes were broken, chimneys twisted or thrown down, mantel ornaments overturned, etc. Steeples swayed to and fro. On Russian and Telegraph Hills the shock was comparatively light. On the flat between Howard Street and the Mission the shock was most severe. The Custom House was badly damaged. It was poorly constructed. Coffee & Risdon's building (corner of Market and Battery streets) was of brick, three stories high, and unfinished. The walls of a portion of this fell, killing a man. The machines in the Union Foundry (First and Mission streets) were put out of order. Several buildings in this neighborhood were more or less wrecked. The tall chimney of the San Francisco Gas Works (Howard and Fremont streets) was thrown down. The Mission Woolen Mills were damaged badly. As in 1865, a small crevasse was opened on Howard Street, beyond Sixth. The Deaf, Dumb and Blind Institution was damaged. The greatest damage was done in a belt several hundred feet wide, running northwest and southeast, commencing at the Custom House and ending at the Folsom Street wharf. The tall chimney of the United States Mint was damaged. The ferry steamer *Contra Costa* was near Angel Island and felt the shock strongly. Shocks were noted at 7.53; 8.10; 8.15; 8.30; 8.45; 9.20; 9.35; 10; 10.30; 11.05 a. m., and at 12.15 and 2.58 p. m. [the 10.30 shock was *vertical* at Pine and Mason streets.—J. R. J.]. Cliff House, S. F.; an unusual commotion in the sea, and the waves came fifteen or twenty feet further inland than usual. There were about thirty casualties in the 150,000 inhabitants. Five deaths occurred from falling walls, etc. Not a single well-built house on the solid land suffered materially, whether of brick, stone, or wood. Wooden houses suffered least. H. Ms. Also derived from S. F. daily papers of the few days immediately following the shock. See Rowlandson, *et seq.* No register of this shock on the tide-gauges at San Diego and Fort Point.

Oakland. At the beginning, a roaring sound like artillery crossing a bridge was heard coming from the Mission towards Pine and Mason streets, S. F.—J. R. J. The draw of the railroad bridge was thrown twelve inches out of line. The water of the bay was smooth and no wave was noticed due to the shock. Buildings and chimneys fell to the south (IX).

Martinez. The earthquake was heavy at 7.57 a. m. The Court House was wrecked (IX).

Alameda. Several buildings badly damaged (IX).

San Leandro. Several buildings badly damaged; one man killed (IX).

Alvarado. Buildings damaged (IX).

San Lorenzo. Several chimneys thrown down (IX).

Haywards. Very severe; twenty-two shocks during the morning. Not a building that was not damaged, and several wrecked (IX).

Amador Valley. The shock was light (VIII).

Mare Island Navy Yard. Chimneys thrown down. The shock threw down a person who was walking (VIII or IX).

Vallejo. Chimneys thrown down (VIII).

Redwood City. The brick Court House wrecked (IX).

Marysville. Light shock (VII).

Grass Valley. Severe, causing lamps, etc., to vibrate.

Sonora. Slight shock.

San Mateo. Severe, with damage to property.

Placerville. Light shock.

Folsom, Sacramento County. Sharp shock.

At sea. The *Pactolus* was at anchor, in deep water, fifteen miles west of the Heads. The shock was severely felt.

San José. Buildings damaged, chimneys thrown down.

Santa Clara. Buildings damaged, chimneys thrown down.

Gilroy. Chimneys thrown down.

Santa Cruz. Brick buildings cracked.

Healdsburg. Severe; clocks were stopped.

Woodland (Yolo County). Severe.

Centerville. Buildings destroyed and others badly damaged.

Mission San José. Buildings destroyed and others badly damaged.

San Juan. Severe shock.

Sacramento. Severe shock, no damage.

San Rafael. Severe shock, chimneys thrown down.

Petaluma. Buildings damaged, chimneys thrown down.

Santa Rosa. Buildings damaged, chimneys thrown down.

Somerville, Antioch, Clayton. Buildings damaged, chimneys thrown down.

Los Angeles. No shock felt.—H. Ms.

Hon. T. G. Phelps visited the seacoast from Half Moon Bay to Pescadero soon after October 21 and found all chimneys down or twisted (VIII). At Belmont no chimneys overthrown (VII).

1868. October 21; 7:50 a. m.

At 7h. 50m. a. m., after dull rumblings, heavy shocks, lasting 140 seconds, began; six or seven shocks before 11 a. m.; and at 3 p. m. another, and the last about midnight. Earthquakes were felt over all California; the heaviest were the following: Sacramento, 7.59; Oakland, 10.30, 11.45; Marysville, 7.55 and 8 and 1.25 a. m.—Fuchs.

1868, October 21, San Francisco. The shock was longer and more severe than that of October 8, 1865. Several persons were killed by falling cornices. The shock was felt in the interior in every direction, and with severity. The surface of the earth visibly undulated. Brick buildings were tumbled down or badly cracked in several places, including Oakland and San Leandro, and several lives were lost. Not a single thoroughly good building, even in the lower part of the city, was seriously injured.—*S. F. Bulletin*, October 21, 1868. Hon. Horace Davis writes that the destruction in S. F. was greatest along the old beach-line of the city, beyond which the soil had been filled in. Photographs in my possession seem to show that the damage to substantial buildings in S. F. was small.—E. S. H.

1868, October 21, San José. The oscillation was from southeast to northwest and lasted one-half minute. Considerable damage was done to property. No lives were lost. Damage to Presbyterian Church amounted to \$2,000.—*San José Advertiser*, October 4, 1868.

1868, October 21. Account of the earthquakes in San Francisco, October 8, 1865, and October 21, 1868.—*San José Pioneer*, February 9, 1878. This earthquake was not felt in San Diego.—B. Ms.

1868, October 21, San Leandro. One man was killed attempting to escape through the falling walls of the Court House, which, with the jail, was laid in ruins. Several concrete buildings were entirely destroyed, and a great many frame buildings partially so. After the earthquake was over, only two chimneys remained standing. The loss was not much short of \$100,000. Neighboring towns were severely shocked. Haywards was laid in ruins. But little injury was done at Oakland. It was the most severe shock experienced on the coast by white men up to that time.—*San Leandro Gazette*, October 24, 1868.

1868, October 21, Petaluma. Considerable property destroyed. Vibrations from east to west. Three distinct shocks following

each other in rapid succession, lasting from ten to fifteen seconds. Light shocks for four hours afterwards.—*Petaluma Journal and Argus*, October 22, 1868.

1868, October 21, Sacramento. Severe earthquake. The water of the river receded, and in a short time returned in a wave at least two feet in height.—*Sacramento Bee*, October 21, 1868.

1868, October 21, Santa Cruz Mountains, near Pescadero. Great damage done to the redwood trees. Limbs fell to the ground, and large pieces of rock rolled down the mountains. It is said that the waters of Pescadero Creek became muddy in a moment, and that the surface was covered with bubbles, which burst with a slight report and a small flame when a match was applied to them.—*Grass Valley Union*, October 29, 1868.

1868, October 21. See brief report on the cause and effect, by the committee of merchants in San Francisco Chamber of Commerce report, 1870. See also *Alta*, December 1, 1868.

1868, October 21; about 8 a. m., in San Francisco. Killed five persons by throwing loose bricks from the tops of buildings upon them, and no person was severely injured in a house. The better class of structures was not damaged. A dozen brick buildings, with weak foundations on made ground, were cracked, so as to be untenable.—Hittell, *History of San Francisco*, pp. 370-7. Hon. A. S. Hallidie reports the interesting fact that the air was filled with horizontal layers of smoke and dust with layers of clear air between. The appearance was striking.

1868, October 21. Brick and concrete buildings in Pacheco were destroyed. The shocks were severely felt throughout Contra Costa County, except at Antioch. There no chimneys were thrown down, nor were any walls cracked.—*Pacheco, Contra Costa County, Gazette*, October 24, 1868.

1868, October 21. Three heavy and distinct shocks were felt in Nevada City. The most severe known up to this time.—*Nevada City Daily Transcript*, October 22.

1868, October 21. The shock was severe, or very severe, at Martinez, Alameda, Alvarado, San Lorenzo, Haywards, Mare Island, Vallejo, Redwood, Grass Valley ("quite a severe shock"), San Mateo, San José, Gilroy, Santa Cruz, Healdsburg, Woodland (Yolo County), Centerville, Stockton, San Rafael, Petaluma, Santa Rosa, Contra Costa County.—H. Ms. Yolo County.—B. Ms.

1868, October 21. The shock was light at Marysville, Sonora, and Amador Valley.—H. Ms. No shock was felt at Los Angeles, San Diego, etc.—H. Ms. For a complete account of this shock in Alameda County, see Halley, Centennial Book of Alameda County, pp. 257-269. Articles on this earthquake may be found in the following places (from the Bancroft Ms.): *S. F. Times*, October 22,

23, 24, 26, 1868. Telegrams from all parts of the State, in *S. F. Call*, October 22. *S. F. Abend Post*, October 22. Further particulars, loss of life and property, shock in the interior, and estimated damages to buildings and stock.—*S. F. Bulletin*, October 22 and 23. *Alta California*, October 22, 23, and editorial on earthquakes in *Alta*, October 24. *Lloyd's Lights and Shades*, pp. 318 and 324. Earthquake throughout the State; twelve persons killed.—*Sacramento Union*, October 22. *S. F. Bulletin*, October 21, 22, 23, 24, 25, 27, 29. *S. F. Spirit of the Times*, October 24. San Leandro and Haywards. Long article in *Alta* of October 27. *S. F. Call*, October 23. Facts about earthquakes; earthquake in the interior.—*Alta*, October 24, 1868. Open crack in Haywards.—*S. F. Call*, October 25. Report of Earthquake Commission.—*Alta*, December 1, 1868. *S. F. Chronicle*, October 21, 22, 23, 24. Petaluma.—(Oregon) *Deutscher Zeitung*, October 24, 1868. *S. F. Monitor*, October 24. *Cal. Christian Advocate*, October 29. *S. F. Golden Era*, October 24. *S. F. Golden Era*, October 31 (two articles). Grass Valley. Vibrations from southwest to northeast.—*Grass Valley Union*, October 22. *San Leandro Democrat*, October 24, 1868. *Vallejo Weekly Chronicle*, October 31.

Professor Hanks says that a circle with Haywards as a center and 173 miles as radius will cover every point where the vibration was felt. The area of such a circle is 94,000 square miles, or about three-fifths of the area of California.—H. Ms.

Fruitville, Alameda County. Professor Bunnell was walking in a field at the time of the first shock. He heard a loud report, which he referred to the direction of S. F., and immediately felt the earth tremble so violently as to make it difficult to stand upright. Dr. Gibbons kindly communicates the following record of forty-nine shocks during October and November: October 21; two heavy shocks, twelve light ones (14) during the day, four during the night. October 22; eight day and night. October 23; four till 9 p. m. October 24; three from 6 a. m. to 9 p. m. October 25; three. October 26; two, very heavy. October 27; one. October 28; two. October 29; one. November 3; one, at 7 a. m. November 10; one. November 11; one. November 15; one. November 16; three, or forty-nine in all. Soon after the earthquake of 1868, the feast-day of St. Emidius (August 9) was set apart as a day of prayer's for protection against earthquakes by Pope Pius IX on the request of the Archbishop of California.

1868. October 22;

Tremors in S. F., Cal.—Fuchs.—Perrey.

1868. October 23; 2:20 a. m.

Smart shock, San Francisco, Cal.—T. T. Another shock 7.30 a. m.—*Appleton's Annual Cyclopædia*, 1868. 2.15 a. m.; then two light shocks; and another at 7.30 p. m.—Perrey.

1868. October 25;

Tremors in S. F., Cal.—Fuchs. Slight shock at 8 a. m.—S. F. D. A strong shock, very long, at 8.05 a. m.—Perrey.

1868. October 26; about 11 a. m.

Two shocks, San Francisco, Cal.—S. F. D.

1868. October 26; 11:54 p. m.; V.

Smart shock, San Francisco, Cal.—T. T. Also in Oakland.—Fuchs.—Perrey.

1868. October 27; V.

Heavy shock in Oakland, Cal.—Fuchs. S. F.—Perrey.

1868. October 30; 10:20 p. m.; IV.

Slight shock, San Francisco, Cal.—T. T.

1868. October 31;

S. F., Cal.—B. Ms.

1868. November 1; 6:32 p. m.; IV.

Slight shock, San Francisco, Cal.—T. T. Petaluma, Cal.—B. Ms.

1868. November 4; 8:58 p. m.; V.

Smart shock, San Francisco, Cal.—T. T. Two "pretty severe" shocks at Monterey.—B. Ms.

1868. November 5; V.

Heavy shocks in S. F., Cal.—Fuchs. On this day also at Victoria, Vancouver.—Perrey.

1868. November 17; 1:30 p. m.; VI.

Quick and violent shock at Santa Cruz.—*Santa Cruz Times*, November 20, 1868. Quoted in *S. F. Bulletin*, December 1.—B. Ms. *S. F. Call*, December 1, 1868.

1868. November 20;

San Francisco.—Perrey.

1868. November 30;

Several shocks in Oakland, Cal.—B. Ms. *S. F. Bulletin*, December 1.

1868. December 26;

Two shocks at Nevada City, Cal.—B. Ms.

1868. December 31; 11:56 a. m.; III.

Two slight shocks at S. F., Cal.—B. Ms.—*S. F. Times*, January 1, 1869.

1869. January 7; V.

Two sharp shocks near the Newton Copper Mine, Amador? County, Cal.—B. Ms.—(Jackson) *Amador County Ledger*, January 9, 1869.

1869. January 22; about 4 a. m.

At Haywards, Alameda County.—B. Ms.—*S. F. Herald*, January 23, 1869.

1869. January 28; IV.

Slight shock in S. F., Cal.—Fuchs.—Perrey. 4 a. m., shock in S. F., and Santa Cruz Mts.—B. Ms.—*S. F. Times*, January 30, 1869.

1869. January 29; 12 m.; IV.

Slight shock in S. F., Cal.—Fuchs.—Perrey. No notice of this shock in Mr. Sawin's Diary, Santa Cruz.

1869. January 29; 1:45 p. m.; V.

Heavy shock at Watsonville, Santa Cruz County.—B. Ms.—*S. F. Times*, January 30, 1869.

1869. February 1; 10 p. m.; IV.

Slight shock at Livermore, Alameda County, Cal.—B. Ms.—*S. F. Herald*, February 3, 1869.

1869. February 10;

San José, Cal.—Fuchs.—Perrey. Santa Clara.—B. Ms. Submarine earthquake recorded by the tide-gauge at Fort Point, S. F.—*Mining and Scientific Press*.

1869. February 13; 4:30 a. m.; IV.

Light shock in S. F., Cal.—Fuchs.—Perrey. 4 a. m.—*S. F. D.*

1869. March 11; 9:45 p. m.

San José, Santa Clara County, Cal.—B. Ms.—*S. F. Times*, March 16, 1869.

1869. April 1; 5:47 p. m.; V.

Smart shock, San Francisco, Cal.—T. T. Also in San José, Petaluma, and Stockton.—Fuchs.—Perrey. Lasted eighteen seconds in S. F.; occurred at 5.55 p. m. at Stockton, at Napa City, and Sonoma.—B. Ms.

1869. April ?;

Tuolumne County, Cal.—B. Ms.—*S. F. Times*, April 17, 1869. [The above is the reference in B. Ms., but an examination of this paper failed to find the item.]

1869. May 19; 11:20 a. m.; III.

A slight shock at S. F., Cal.—B. Ms.—*S. F. Times*, May 20, 1869.

1869. May 30; 10:37 a. m.

S. F., Cal.—B. Ms.—*S. F. Times*, May 31, 1869.

1869. June 1;

Earthquake sea waves recorded at Ft. Point (S. F.).—*Mining and Scientific Press*.

1869. June 2;

Santa Cruz and Gilroy papers speak of recent earthquakes, and the Fort Point tide-gauge recorded an earthquake wave.—*Mining and Scientific Press*.

1869. June 12; 9:15 p. m.; V.

Sharp shock at Eureka, Humboldt County, Cal.—B. Ms.—*S. F. Times*, June 29, 1869.

1869. June 25; 6:20 a. m.

S. F. and San José, Cal.—B. Ms.—*S. F. Times*, June 26, 1869.

1869. July 23; 2:28 p. m.

Sharp shock at San Juan, Monterey County.—B. Ms.—*S. F. Times*, August 3, 1869.

1869. July 24;

Shock at San Juan, Monterey County.—B. Ms.—*S. F. Times*, August 3, 1869.

1869. September 5;

Arizona, California [*sic*].—Perrey, *Mém. Cour.* 22, p. 80.

1869. September 12;

?, California.—Fuchs.—Perrey.

1869. September 13;

— California.—Fuchs. Nevada City, Cal.—B. Ms. On the coast, a light shock; heavy at San Luis Obispo (V?); light at Sacramento (IV?).—Perrey.

1869. September 14;

Heavy shock in San Luis Obispo, Cal.—Fuchs.—[See September 13, Perrey's note.—E. S. H.]

1869. September 15;

Light shock in Sacramento, Cal.—Fuchs.

1869. October 6; midnight.

At sea, fifty miles from Mendocino, Cal.—B. Ms.—*S. F. Times*, October 7, 1869.

1869. October 7; at night; V or more severe.

Severe shock at San Bernardino, Cal.—B. Ms.—*S. F. Times*, October 16, 1869; also October 19, 1869.

1869. October 8; 1:30 a. m.; VIII.

Severest shock ever felt at Ukiah Valley, Mendocino County, Cal.—B. Ms.—*S. F. Times*, October 14, 1869. (See 1868, Sept. 26.—E. S. H.)

1869. October 21;

New River Station (near San Diego?).—B. Ms.

1869. October;

Los Angeles.—B. Ms.

1869. December 14; morning.

Santa Cruz, Cal.—B. Ms.—*S. F. Golden Era*, December 19, 1869.

1869. December 15; V.

Heavy shock in San Luis Obispo, Cal.—Fuchs.—Perrey.

1869. December 19; p. m.

Several shocks in Mariposa, Cal., and in the mines of Virginia City, Nevada. Also a. m. December 20.—Fuchs. In the a. m. several shocks at Mariposa.—Perrey.

1869. December 20; 8 p. m.; V.

Strong shock in Grass Valley, Cal.; slightly felt at Sacramento (IV?).—Fuchs.—Perrey. At Ophir Hill also.—B. Ms.

1869. December 26; 5½ p. m.

Three shocks in Marysville; others in Stockton, etc. In Sacramento, two shocks in the daytime; at 9 p. m., another shock here, and at Grass Valley, etc. Twenty-six shocks at Mariposa during this night.—Fuchs. Nevada City and Grass Valley.—B. Ms.

Mokelumne Hill, Calaveras County, Cal. A house near Railroad Flat (VIII?) was lifted bodily several times.—B. Ms. Lowe Hill; Stockton 5.52 p. m.; Truckee; Grass Valley; Nevada; Chico; Mariposa.—Perrey. Nevada City.—B. Ms.

1869. December 27;

This day was the maximum for the California earthquakes of this month; 2 a. m., very heavy shocks in Marysville (VIII); 2.10 a. m., houses thrown down in Sacramento, etc. (IX).—Fuchs.

1869. December 27; 2 a. m.

Marysville, Sacramento, 2 a. m.—Perrey.

1870?

Puget Sound (VII). "Several old settlers insist that there were severe shocks, but none can state the day or time. They may refer to 1872?"—P.

1870. January 1; "end of January."

San Francisco, Cal.—Fuchs.

1870. January 3;

San Bernardino, Los Angeles.—B. Ms.—*S. F. Abend-Post*, January 6, 1870.

1870. January 3; 11 p. m.; V.

"Quite a shock," Bakersfield, Kern County, Cal.—*S. F. Bulletin*, January 6, 1870.—Fuchs.

1870. February 4; IV.

Light shock in S. F., Cal.—Fuchs.

1870. February 13-14; night; IV.

Two light shocks in S. F., Cal.—Fuchs. Oakland, Petaluma.—B. Ms.

1870. February 17; 12h. 12m. 22s. p. m.

Two smart shocks at San Francisco, Cal. (V).—T. T. Also in Petaluma, Sacramento, and San José.—Fuchs. Vallejo, Santa Rosa, Santa Cruz, San Rafael.—B. Ms. Light shock at Monterey (III? IV?).—Fuchs.

1870. March 4;

Grass Valley, Cal.—B. Ms.

1870. March 11;

Prescott, ? California.—Fuchs. (Arizona??)

1870. April 2; 11:48 a. m.; VI.

Smart shock at San Francisco, Cal.—T. T. Six seconds duration.—Fuchs. Pacheco, Contra Costa County.—B. Ms.—Berkeley; light articles overthrown (VI).—John Le Conte.

1870. April 13; 3:30 a. m.

Two shocks at S. F., Cal. Perhaps another at 2.30 a. m.—B. Ms. (Possibly the times are wrong.—E. S. H.)

1870. April 17;

Cahto, Mendocino County, Cal.—Fuchs.

1870. April 24; no time given; IV.

Slight shock, S. F., Cal.—S. F. D. (See April 25. E. S. H.)

1870. April 25; 10 p. m.; III.

Light shock in S. F., Cal.—Fuchs.

1870. April 26; a. m.; III.

Light shock in S. F., Cal.—Fuchs.

1870. April;

San Bernardino.—B. Ms.

1870. May 4;

Grass Valley, Cal.—B. Ms.

1870. May 8;

Gilroy.—B. Ms.

1870. May 12;

Gilroy.—B. Ms.

1870. August 6; 11:20 p. m.; V.

Heavy shock in Ukiah.—Fuchs.

1870. August 9; midnight; V.

Mendocino; duration 10 seconds.—B. Ms.

1870. September 2; 3 a. m.

Monterey, Cal.—Fuchs.

1870. December 4; 2 a. m.

The bark *Amethyst* felt a severe shock of earthquake 45 miles W. S. W. by compass from Cape Mendocino.—From *Pacific Coast Pilot*, communicated by Professor George Davidson, U. S. C. and G. Survey.

1870.

Moleje, Lower California, five severe shocks during the year.—C. G. R.

1871. February 6; 7:17 a. m.

Two shocks, San Francisco, Cal.; also at San José and Santa Cruz.—*Mining and Scientific Press*.

1871. February 9;

San Francisco, Cal.—S. F. D.

1871. March 2; 1:05½ p. m.

Severest for several years in Eureka, Humboldt County, Cal. (VII?); duration, twenty seconds; another shock twenty-five minutes later; another, 7.30 p. m. This shock was even more severe to the south and east, at Rhonerville, Hydesville, in the same county (VIII).—B. Ms.—*S. F. Call*, March 15, 1871. Chimneys thrown down at Rhonerville and Petrolia (VIII). The oscillations lasted twenty minutes.—Appleton's *Annual Cyclopedia*, 1871.

1871. March 2; VIII.

Light-keeper's house at Mendocino, Cal., injured.—B. Ms.—*S. F. Call*, March 28, 1871.

1871. March 6; III.

Weak shock in Carthago, Inyo County, Cal.—Fuchs.

1871. April 2; 7:49 p. m.; IV.

Shock at San Francisco, Cal.—T. T. Two light shocks.—Fuchs. Also in Contra Costa County.—B. Ms.

1871. April 23; III.

Three light shocks at S. F., Cal.—S. F. D.

1871. May 19;

Shocks in Washington Territory, and on Mt. Raynier. During the whole month shocks on the coast.—Fuchs. Tacoma.—P.

1871. June 6; about 9 p. m.; V or more severe.

Two strong shocks at Bear Valley, California.—Fuchs.

- 1871. June 21;**
Strong earthquakes, Cal.—Fuchs.
- 1871. July 5; 6:54 a. m.**
Visalia, Cal.—Fuchs. Also severe shock at Independence and Swansea, Inyo County (VI?).—B. Ms.
- 1871. July 11; 7 p. m., a. m. ?**
Independence, Inyo County, Cal.—B. Ms.
- 1871. July 11; 7:30 p. m., VI.**
A shock more severe than that of July 5th, at Swansea, Inyo County, Cal.—B. Ms. Another shock at 12 midnight.—B. Ms.
- 1871. July 11; 9 p. m.**
Bishop's Creek, Inyo County, Cal.—B. Ms. Severe at Owensville (V?).—B. Ms.
- 1871. July 12; midnight.**
Swansea, Inyo County.—B. Ms.
- 1871. July 12; 12 m.**
Bishop's Creek, Inyo County, Cal.—B. Ms. Severe at Owensville (V?).—B. Ms.
- 1871. July;**
Kern County.—*Mining and Scientific Press*, July 22, 1871.
- 1871. August 26;**
Santa Rosa.—B. Ms.
- 1871. August 31;**
Gilroy.—B. Ms.
- 1871. Early in September;**
Castraville, Monterey County.—B. Ms.
- 1871. September 15; 6:45 a. m.**
Gilroy, Cal.—Fuchs.
- 1871. September 18;**
S. F., Cal.—S. F. D.
- 1871. October 21;**
Calistoga.—B. Ms.
- 1871. October 27;**
Temecula, near San Diego, Cal.—B. Ms.
- 1871. December 12; 2:30 a. m.; V.**
Quite severe shock at Humboldt.—B. Ms.—*S. F. Call*, December 24, 1871.

1871. No date;

Twenty shocks during the year, no dates given, at Moleje, Southern California.—Fuchs.

1872. February 6;

Santa Barbara, "the first shock for fifteen years."—B. Ms. [There are shocks recorded, 1857, March 14, 1858, September 2, and 1860, April 16, within the period of fifteen years; but none from 1860 to 1872—twelve years.—E. S. H.]

1872. February 11;

Stockton.—B. Ms.

1872. February;

Fresno County.—B. Ms.

1872. March 17; about 1 o'clock; VIII.

Severe shock at Lone Pine, Cal.—C. G. R. "Frightful."—Fuchs.

1872. March 18;

S. F., Cal.—S. F. D.

1872. March 23;

San Diego.—B. Ms.

1872. March 25; (V?)

Severe shock at Jackson, Amador County, Cal.—B. Ms.

1872. March 26;

Great Inyo County earthquake. Shocks were felt on this day in the City of Mexico, New Madrid, Mo., and many other distant points.—B. Ms. Fuchs does not mention any earthquakes on this day except one on the coast of Chili. On March 27, one at Oajaca, Mexico. He does not mention an eruption of Colima. The earthquakes of March and April, 1872, were, according to Whitney, (*Overland Monthly*, vol. 9, p. 271), as follows:

March 6; central and eastern Germany.

March 11; destructive shocks in Japan.

March 23; Unionville and Winnemucca, Nevada.

March 26; the great earthquake at Inyo, which extended over all of California except its northern end, and throughout nearly all of Nevada.

March 26; City of Mexico—8-9 a. m.

March 26; Paducah, Ky.

March 28; Salt Lake City.

April 3; terrible shock at Antioch.

April 14; Accra; gold coast of Africa.

April 15; volcano of Merapi, Java, in eruption.

April 16, 17, 18; severe shocks in Iceland.

April 24; great eruption of Vesuvius.

April —; great eruption in the Philippine Islands.

March 26. The shock was felt at far as Winnemucca, Nevada—462 miles east of San Francisco.—B. Ms. Long, rolling, but moderate shocks in S. F. (V).—T. T. The persistent duration of the oscillations was remarkable and unique at S. F.

March 26. At Big Pine, Inyo County (X), there was a fissure opened from 50 to 200 feet wide, in places 20 feet deep, extending for miles, close to the eastern base of the Sierras. Near Fish Springs the earth was heaped up in ridges 5 to 10 feet high and 20 to 30 feet across. From Independence to Bishop's Creek (50 miles), the ground is cracked all over the surface. At Bishop's Creek the shock was severe, but light compared with that to the south. It commenced at 2.30 a. m., and from then to 6.30 a. m. there were not less than 50 shocks.—B. Ms.—*S. F. Bulletin*, March 28, April 1, 1872.

March 26. Lone Pine, Inyo County, Cal. (X). In Lone Pine every adobe and stone building was leveled to the ground. Sixty persons were killed and wounded in that place alone.—B. Ms. At Independence the damage to property was great. In other places in that county the loss of life and property was considerable. In Lone Pine the damage to property was \$132,000; at Independence, \$43,000; at Camp Independence, \$26,000; in the county, \$237,000.—B. Ms.—*Inyo Independent*, March 30, 1872.

In the same paper of April 13 the editor says the losses were overestimated. The total loss was less than \$100,000. (The people at Lone Pine stopped the paper for *underestimating* the loss.)—*Inyo Independent*, April 20, 1872. During this earthquake not a single wooden building in Inyo County was injured to a dangerous extent, and not a single person in such a building was injured at all. One thousand shocks in two days.—Fuchs.

March 26. The Inyo earthquake was felt from the City of Mexico to Oregon. Shocks were felt on the same day at Paducah, Ky. At Camp Cady, A. T., its force was sufficient to move heavy wagons several feet (IX). The volcano of Colima, Mexico, burst into eruption on this day.—B. Ms.—*Inyo Independent*, April 20, 1872. [Note.—No eruption of Colima is mentioned by Fuchs.]

March 26. Millerton, Fresno County, 2.15 a. m. Shocks continued until 11 o'clock of the same day. No damage was done. At Bennett's Station, Merced County, a stone house was thrown down (IX). At Chowchilla, quite severe. At Fort Miller, quite severe.—B. Ms.—*Fresno Expositor*, April 30, 1872.

March 26. Fifty-two out of fifty-nine buildings were thrown down in Lone Pine, Inyo County. At Los Angeles artesian wells were seriously affected by earthquake. Some of them stopped entirely. At Glennville, Kern County, large and important springs opened. The larger Owens Lake was from 3 to 5 feet higher after the earthquake than before. The little lake 3 miles from Lone Pine entirely disappeared. Owens River, at Independence, dried up and remained dry for six hours. On Tuesday, the first day of the shocks, a dense fog or smoke prevailed over the valley. After the shocks, smoke and fire were seen issuing from the earth, the flames being blue. A river was opened and running between Lone Pine and Inyo Lake, 75 yards wide and 2 feet deep.—B. Ms.—*Healdsburg Russian River Flag*, April 25, 1872.

March 26. Inyo County. The night before was calm, clear and frosty, with the moon just past the full. At Big Pine the shock was very severe. At Bishop Creek somewhat less so. At Sierra, brick buildings were cracked. At Benton, the same. At Swansea buildings were leveled. At Belmont, a few stone cabins were thrown down (X).—B. Ms.—*Inyo Independent*, March 30, 1872.

March 26. Yosemite Valley (IX), many rocks fell, filling the valley with dust and smoke. The largest trees waved to and fro and were bent about like mere twigs.—B. Ms.—*S. F. Bulletin*, April 10, 1872.

The water of Owens Lake, Inyo County, rose very rapidly in July, 1872, sometimes as much as 4 or 5 inches in a night. During this period the water in Owens River, the main and almost only source of supply, was constantly diminishing. For a short time after the earthquake the waters of the lake fell several feet and became stationary, remaining at about the same point until the time mentioned. Previous to the earthquake the lake had been steadily rising for 10 years. Innumerable springs broke out all along the foothills.—B. Ms.—*Inyo Independent*, August 3, 1872. At Lone Pine, Big Pine, Independence, the shock was severest; at Bishop's Creek, Aurora (IX), Benton, and at the south end of Owens Lake the shock was less severe.

March 26 to April 10. Inyo, Cal. The shocks continued up to April 10 at intervals of a few hours, and in the mountains near by explosions were frequent, resembling distant artillery.—B. Ms.—*Alta*, April 11, 1872, April 12, 1872.

March 26. Cerro Gordo and Eclipse Mines, Inyo County, Cal. The rocking motion was distinctly observed, especially in the timbering, and the miners went to the surface, but soon resumed work.—B. Ms.—*Inyo Independent*, April 20, 1872.

March 26, San Francisco, 2.30 a. m. The shock was comparatively light in San Francisco, but was the most severe on record at other places. It extended at least from Red Bluff, in the north,

to Visalia, in the southern part of the State, and is said to have reached up into the Sierras to an elevation of 3,000 or 4,000 feet. The whole of the Sacramento, San Joaquin and Tulare Valleys were disturbed, the area of disturbance being 500 miles long by 60 to 100 miles wide. The shock was severest in the valleys. It appears to have been of greatest energy near Visalia, in the Tulare Valley, which is the bed of a former lake (IX). The alluvium was profoundly and frequently agitated, and shocks were long continued.—B. Ms.—*S. F. Bulletin*, March 26, 1872.

March 26. Marysville. Motion from south to north. Bangor, shock from the east.—B. Ms.—*Marysville Appeal*, March 27, 1872.

March 26. At the Kearsarge Mill in Inyo County, located at an altitude of nearly 8,000 feet above the sea, electric shocks from a stove were felt.—B. Ms.—*Inyo Independent*, April 20, 1872.

March 26. Mariposa County. Several shocks all through this section of the country, continuing for several days.—B. Ms.—*Mariposa Gazette*, March 29, 1872.

March 26. Los Angeles. Vibrations were from east to west. In Anaheim they were from north to south. In Visalia the most damage was done. Brick buildings were strained and cracked. Some walls were thrown down. Upwards of 30 shocks occurred at Visalia.—B. Ms.—*Los Angeles Evening Express*, March 26, 1872.

March 26. Geyser Gulch, near headwaters of the San Joaquin (X). Miners' cabins in this vicinity were thrown to the ground with violence. This place is 40 or 50 miles from Independence, Inyo County.—B. Ms.—*Fresno Expositor*, April 10, 1872.

March 26. Grass Valley (VIII). Steeple of St. Patrick's Church swayed to and fro violently. *Grass Valley Union*, March 27, 1872.

March 26. Sacramento (VII). Several shocks, although no damage was done.—*Folsom Telegraph*, March 30, 1872.

March 26. Folsom (VII). Three distinct shocks at half-past two in the morning. Salmon Falls, the first shock lasted 2 minutes and was quite severe.—*Folsom Telegraph*, March 30, 1872.

March 26. Napa.—*Napa Reporter*, March 30, 1872.

March 26. See article by Prof. Le Conte.—*S. F. Bulletin*, April 12, 1872.

March 26. Los Angeles. B. Ms.—*Los Angeles Evening Express*, March 26, 1872.

March 26, 2.25 a. m. Placerville, Placer County, two or three distinct shocks in quick succession.—B. Ms.—*Placerville Democrat*, March 30, 1872.

March 26. Monitor.—B. Ms.—*Alpine Miner*, March 30, 1872.

March 26. Nevada City (VII), two shocks were felt, severe enough to cause nausea.—B. Ms.—*Nevada City Daily Transcript*, March 27, 1872.

March 26. The shock was reported as *light* at Antioch, Martinez, Santa Cruz, Pacheco, Napa.—H. Ms. At Woodland, Yolo County, the shock was felt at 2.25 a. m. and lasted 30 seconds.

March 26. The shock was reported as *severe*, or *very severe*, at Sacramento, Visalia, Red Bluff, Copperopolis, Sonora, Sutter Creek, Forest and Iowa Hills, Placerville, San José, Stockton, Santa Barbara, Hill's Ferry (Stanislaus County), Pescadero, and along the coast, Woodland (Yolo County), Chico, Colusa, Alpine County, San Diego, Salinas, Virginia City (Nev.), Marysville, Bakersfield, Los Angeles, San Juan Capistrano, Fort Tejon, Flores, Inyo Valley, Mariposa, Calaveras, Eureka.—H. Ms.

March 26. Articles on this earthquake may be found in *S. F. Bulletin*, March 26, 27, 28, 29, 30, April 1, 2, 3, 5, 8, 13, 24, May 10, 17; *Alta*, March 31, April 3; *Call*, March 27, 31, April 13, May 17; *Chronicle*, March 29 to May 4; *S. F. Golden Era*, March 31; *Pacific Observer*, March 29; *Inyo Independent*, April 6.

March 26. Accounts in *Mining and Scientific Press*, March 30, 1872, April 6 (description of the region by H. G. Hanks), April 30, May 11 (underground shocks), May 25. Professor Whitney, in *Overland Monthly*, Vol. 9, gives a very full and scientific account of this earthquake. "A fissure was opened in the earth from about 2 miles south of Lone Pine, extending ten miles further north. This fissure was 4 feet wide, and the ground on the east side sank from 4 to 12 feet lower than that on the west side (or the west side was raised). At the same time the ground on the east side was moved bodily 10 feet or so towards the north (or the other to the south). This was clearly shown by the position of fences running east and west."—Verbal account of Capt. Keeler, who has given me a photograph showing the shifting of the fences at a point 1½ miles south of Lone Pine.

1872. March 28;

Nevada City, Cal.—B. Ms.

1872. March 28;

Visalia.—B. Ms.

1872. March 29; V.

Los Angeles, Cal.; shock lasting 49 seconds, the longest ever felt here, though not the most severe.—B. Ms.

1872. April 3; early in the morning; V.

Two sharp shocks; Visalia, Cal.—B. Ms.

1872. April 3; 4:15 a. m.

Stockton.—B. Ms.

1872. April 9; 7 a. m.

Visalia.—B. Ms.

1872. April 10; 3 to 4 a. m.

Visalia, several shocks.—B. Ms.

1872. April 10; evening.

Sharp shock of extraordinary length.—B. Ms. (where?)

1872. April 10; 7:10 p. m.

Stockton.—B. Ms.

1872. April 10; 7:20 p. m.; V.

Heavy shock at Tuolumne, which was also felt at Mokelumne Hill.—
B. Ms.

1872. April 11; VI.

Tuolumne; severe shock, 4 a. m.; another, 5.30 a. m.; one more
severe at 1 a. m. (*sic*); another at 9.30 p. m.; another severe at 10
p. m.—B. Ms.

1872. April 12;

Tuolumne, three shocks, 2.30 a. m.; one at 4 a. m., two at sunrise.—
B. Ms.

1872. April 13; VI.

Round Valley, Inyo County, severe shock.—B. Ms.

1872. April 18; VII.

Cerro Gordo, Inyo County, very severe shock.—B. Ms.

1872. April 23;

Placerville, Cal.—B. Ms.

1872. April 28;

Millerton, Fresno County, Cal. A shock as violent as that of March
26, 1872 [?], though shorter.—B. Ms.

1872. April 28; V.

Severe shock at Nevada City, Cal., 8 seconds duration.—B. Ms.

1872. April 30; III.

Marysville, two light shocks.—B. Ms.

1872. May 1;

Salinas, Gilroy, Cal.—*Mining and Scientific Press*.

1872. May 17; VII.

Lone Pine. *Amer. Jour. Sci.*, IV (1872), p. 3.—C. G. R.

1872. May 21;

Shocks are still frequent in Inyo County. A number of the old
craters are still emitting steam.—B. Ms. *Alta*, May 22, 1872.

1872. June 15;

Millerton, Fresno County, Cal.—B. Ms.

1872. August 23; 4 p. m.

Earthquake waves at Ft. Point for 20 hours.—*Mining and Scientific Press.*

1872. September 14; VII.

Owens River Valley, Inyo County, Cal.—C. G. R. Sharp shocks, but no damage done.—*Mining and Scientific Press.*

1872. September 18; evening.

Yountville, Napa County, Cal.—B. Ms.

1872. October 1;

San Francisco, Cal.—S. F. D.

1872. October 2;

San Francisco, Cal.—C. G. R.

1872. October 12; 4:10 a. m.; V.

Sharp shock. San Francisco, Cal.—T. T. Also Oakland. "A vertical shock."—C. G. R.

1872. October 18;

Millerton, Fresno County, Cal.—B. Ms.

1872. October 19;

Millerton, Fresno County, Cal.—B. Ms.

1872. October 21; 8:05 p. m.; IV.

Light shock, San Francisco, Cal.—T. T. Petaluma.—B. Ms. Also Vallejo, San Rafael.—B. Ms.

1872. November 12; at night.

Stockton, Cal.—C. G. R.

1872. November 21;

Petaluma.—B. Ms.

1872. December 14; 9:20-9:40 p. m.

Oregon and Washington Territory.—C. G. R. (see next paragraphs).

1872. December 14; 21h. 40m. 30s.	Puget Sound. One shock.
1872. December 14; 21h. 46m.; VII.	Puget Sound. Three shocks.
1872. December 14; 22h.	Puget Sound. Several shocks.
1872. December 14; 23h.	Puget Sound. Several shocks.
1872. December 15; 3h.	Puget Sound. Several shocks.
1872. December 15; 5h.	Puget Sound. One shock.
1872. December 16; 9h. 17m. 30s.	Puget Sound. One shock.
1872. December 16;	Eugene, Oregon. One shock.

—P.

872. December 14, 15, 16; VII.

Olympia, W. T. Professor George Davidson kindly refers me to an account of these earthquakes in the *Weekly Pacific Tribune*, Olympia, December 21, 1872: "In an unofficial report to Professor Davidson, at San Francisco, Captain Lawson says, December 14, 1872: Shock occurred precisely at 9h. 40½m. It commenced with a slight movement, gradually increasing for 18 or 20 seconds. Then came the heavy shock, lasting 4 or 5 seconds; then it gradually decreased. In six minutes after the first shock there was another, followed by two others, one minute apart. At 10h. 12m. 40s. there was another shock, and after 11 p. m. there were five others. During the night other shocks were reported (I did not feel them) at 3 and 5 o'clock. On Sunday evening, December 15, at 6h. 37½m., a light shock. December 16, at 9h. 17m. 30s. a. m., another light shock. This shock was felt as far south as Eugene, in Oregon, and as far north as British Columbia—probably even in Alaska. In Victoria and elsewhere on Vancouver Island the shock is said to have been heavier than at any other point heard from. In Olympia we have heard of but a single article broken or damaged by the shock. This was a statuette, which was thrown from top of a "whatnot" and smashed on the floor. In the Seattle stores, we are informed, considerable quantities of crockery and glassware were broken. From what is so far known, the earthquake was confined mainly to the Puget Sound Basin, thence extending north and south with a gradually decreasing force, until it disappeared in a distance of 400 or 500 miles." The direction of the shock (December 14) at Olympia was south to north at first, then southeast to northwest.

872. December 15;

A shock was felt at various places near Puget Sound, W. T.—C. G. R.

872. December 16;

Visalia.—B. Ms.

872. December 16 to 1873, January 4;

Walla Walla. Light shocks almost daily.—C. G. R.

872-1875. (March);

No shocks at San Diego in this period.—B. Ms. [except 1873, Oct. 12.—E. S. H.].

873. January 9; II.

Tacoma.—P.

873. February 2; 3:30 p. m.; IV.

Light shock, San Francisco, Cal., lasting 5 seconds.—C. G. R.

873. February 3; 3 p. m.; IV.

Light shock at San Francisco; severe at San José and Santa Clara (V).—C. G. R. Two shocks.—S. F. D.

1873. March;

San Diego Union speaks of a newly discovered volcanic region near Moleje, in Lower California. In 1872 twenty distinct shocks were felt; in 1870 five severe shocks.—C. G. R.

1873. April 10;

Mission San José.—B. Ms.

1873. April 12; in the evening; IV.

Three light shocks, San Francisco, Cal.—C. G. R.

1873. April 21;

Mission San Gabriel.—C. G. R.

1873. May;

San Bernardino.—B. Ms.

1873. June;

San Bernardino.—B. Ms.

1873. July 15; IV.

Slight shock, Napa, Cal.—C. G. R.

1873. August 29; 4 p. m.; VI.

Heavy shock at Mission San José, Cal.—C. G. R. Severe shock at Redwood, San Mateo County; time not given.—B. Ms. *S. F. Post*, September 3, 1873.

1873. October 12; 1:15 a. m.; V.

San Diego, Cal.—C. G. R.

1873. October 19; 2 p. m.; IV.

Slight shock, Seattle, W. T.; 4 p. m., clouds of smoke [?] were seen pouring from the highest peak of Mt. Rainier.—C. G. R.

1873. November 5;

Nevada.—B. Ms.

1873. November 22; a little after 9 p. m.; VIII.

A shock was felt from Portland, Oregon, to San Francisco, Cal.; most severe at Crescent City, Cal., and Port Orford, Oregon.—C. G. R. Nearly every brick building in Crescent City was injured; chimneys were damaged there and up the coast to Port Orford, in the interior as far as Jacksonville, Oregon, and east from Crescent as far as Happy Camp, on the Klamath.—B. Ms. At sea, N. of Cape Mendocino.—C. G. R.—Tacoma (III).—P.

November 22. Severe shock at Linckville, Klamath Lake, Oregon. In Jackson and Josephine counties, Oregon, and Trinity County, Cal., the shock was strong and lasted nearly a minute.—B. Ms.—Ft. Klamath, Oregon.—B. Ms. Red Bluff; Eureka; Albany (Oregon); Roseburg.—C. G. R.

November 22. This shock was very severe in Washington Territory.
—B. Ms.

1873. December 3; V.
Sharp shock, Santa Clara, Cal.—C. G. R.

1873. December 17; 11-12 p. m.; IV.
Victoria, B. C.—C. G. R.

1873. December ?; [probably 17, E. S. H.]
Olympia. Three shocks.—P.

1874. January 18; III.
Two slight shocks, San Francisco, Cal.—C. G. R.

1874. January 19; III.
Slight shock, San Francisco, Cal.—C. G. R.

1874. March 5; 4:53 a. m.; V.
Sharp and short shock at San Francisco, Cal.—T. T.

1874. March 29;
Alpine County.—B. Ms.

1874. May 24; 2 a. m.; IV.
Two sharp shocks, San Francisco, Cal.—C. G. R. Slight shock.—
S. F. D. [?]

1874. June 11; 8 p. m.; V.
Two sharp shocks, San Francisco, Cal.—C. G. R.

1874. August 3; in the evening; III.
Light shock, Clifton, San Bernardino County, Cal.—C. G. R.

1874. August;
Gilroy, Santa Clara County, Cal.—B. Ms.

1874. December 10;
Nevada [Cal.?].—B. Ms.

1874. December 14;
San Francisco, Cal.—B. Ms.

1874?
Tacoma (II).—P.

1875. January 24; 4 a. m.; VI.
Heavy shock in Butte, Plumas, and Sierra counties, Cal., direction
from N. E.—C. G. R. At Oroville, Taylorsville, Greenville, and
Downieville.—B. Ms. Carson (Nev.), N. E. and S. W., one light
and one quite sharp shock.—C. W. F.

1873. February 7; 2 a. m., 10:45 a. m., 11:45 a. m.
Duration 2 sec. Three shocks, San Francisco, Cal.—C. G. R. Motions vertical. U. S. W. R.
1873. June 18;
San Francisco, Cal.—C. G. R.
1873. June 18; forenoon; III.
Slight shocks in San Francisco.—C. G. R.
1873. June 18; 3:35 a. m.; V.
Sharp shock, San Francisco, Cal.—T. T. 3 a. m.—S. F. D.
1873. August 8; in the morning; V.
Heavy shock was felt at Hollister, Cal.—C. G. R.
1873. October 14; 6 p. m.; V.
A sharp shock at San Francisco and in the Santa Clara Valley, Cal., with a heavy sea, without wind, from Santa Cruz to Cape Mendocino.—C. G. R. 5:55 p. m., S. F., Cal.—T. T.
1873. November 2; VI.
A severe shock at Fort Yuma, Arizona.—C. G. R.
1873. November 7; V.
Heavy shock in San Benito County, Cal.—C. G. R.
1873. November 14; 7:52 p. m.; IV.
Two shocks at San Francisco, Cal.—T. T. San José.—U. S. W. R.
1873. November 15; 7:55 p. m.
San Francisco, Cal.—C. G. R.
1873. November 27; 10:18 p. m.
San Francisco, Cal.—T. T.—C. G. R.
1873. December 2; 2:40 p. m.
Three shocks, Marysville, Yuba County, Cal.—B. Ms. See December 3.
1873. December 3; afternoon; V.
Grass Valley, Cal. "Heavy shock."—C. G. R. Light. Carson (Nev.) 3 p. m.—C. W. F.
1873. December 21;
Santa Barbara, Cal.—C. G. R.
1873. December 23; night.
In Placer, Nevada, and Yuba counties, Cal.—C. G. R.
1873. December 24; in the evening.
Grass Valley, Cal.—C. G. R.

1876. **January 21; between 3 and 4 a. m.; III?**
San José, Santa Cruz, and San Francisco.—C. G. R. "Very gentle" at Santa Cruz about 4 a. m.—Mr. Sawin's Diary.
1876. **March 25; 6 a. m., 1 p. m.; III.**
Two slight shocks, Oakland, Cal.—C. G. R.
1876. **May 10;**
Santa Barbara, Cal.—C. G. R.
1876. **August 18; 1:15 p. m.**
Lat. $41^{\circ} 55'$ N., long. $126^{\circ} 25'$ W., off the southern part of Oregon.—C. G. R. (Heavy.)
1876. **October 6; 9:20 and 10:08 p. m.**
San Francisco, Cal., Oakland, San José, and Angel Island.—C. G. R. (Lasting 10 sec.)
1876. **October;**
White Sulphur Springs. ?—B. Ms.—Ashland (Oregon) *Tidings*, October 28, 1876.
1876. **December 11; 7 p. m.**
At Silver Mountain, Cal., a series of seven shocks within thirty minutes. A slight shock at 3 o'clock the next morning.—C. G. R.
1877. **January 10; 1:15 ?; III.**
A slight shock at Los Angeles, Cal.; at Benedict Cañon, near there, three distinct shocks.—C. G. R.
1877. **January 13; about noon; VI.**
A heavy earthquake forty-five miles southeast of San Diego.—C. G. R.
1877. **February 17; morning; V.**
Heavy shock at Quincy, Plumas County, Cal.—C. G. R.
1877. **May 30; between 2 and 3 a. m.; V.**
Heavy shock at Paso Robles, Cal.—C. G. R.
1877. **May;**
Tidal waves at San Francisco. Diagram given at p. 169 of Milne's *Earthquakes*.
1877. **June 23; a few minutes before midnight.**
Santa Barbara, three shocks.—B. Ms. 11:30 p. m., Bakersfield, Cal. "Vertical."—C. G. R.
1877. **July 2; 10:35 a. m.**
Gilroy.—B. Ms. *S. F. Bulletin*, July 5, 1877.

1877. July 9;

A shock at Sacramento, Cal., lasting one minute.—C. G. R. Carson (Nev.), 11.10 p. m., N. and S.; light.—C. W. F.

1877. August 17; 7:30 p. m.; V.

Heavy shock at Campo, Cal.—C. G. R.

1877. August 27;

Eureka, Humboldt County, Cal.—B. Ms.

1877. August;

S. F., Cal.—B. Ms. *Antioch Ledger*, September 1, 1877.

1877. September 7; 10 p. m.

Yuma, Arizona.—Fuchs.—C. G. R.

1877. September 19; about 4 p. m.

Los Angeles, Cal.—B. Ms.—*S. F. Bulletin*, September 22, 1877.

1877. September 29; 2:30 p. m.

Campo, Cal.—C. G. R.

1877. October 12; 1:53 p. m.; VIII.

Portland, Oregon; 1.45 p. m., Marshfield, Oregon; 1.52 p. m., Cascades, Oregon; 9 a. m., Cascades, Oregon.—C. G. R. (Chimneys overthrown.)—P.

1877. October 26; 5-6 p. m.

Lat. $43^{\circ} 13'$, long. 128° W.—Severe shock.—C. G. R.

1877. November 24; 6:30 a. m., 6:50 a. m.

Two shocks at Red Bluff, Cal. (V).—C. G. R.—S. F. (III).—C. G. R.

1878. January 8;

Santa Barbara, Cal.—B. Ms.—*S. F. Golden Era*, January 12, 1878.—*Stockton Independent*, January 10, 1878.

1878. February 26; 11:56 a. m.; IV.

San Francisco, Cal.—U. S. W. R.

1878. March 17;

Two sharp shocks at St. Thomas, Lower California.—U. S. W. R.

1878. March 18; 6:30 a. m.; III.

Tacoma, W. T.—U. S. W. R.—(Slight.)

1878. April 23; 10 a. m.

Heavy earthquake at *Loreto*, Gulf of California. Shocks continued till May 3d.—Fuchs.

1878. May 8; 8:25 p. m.; VI.

From Red Bluff to Sacramento City, Cal., also in Mendocino County.—C. G. R. (Clocks stopped.)

1878. May 21;
San Bernardino, Cal.—U. S. W. R.
1878. June 11-12; 11:12 p. m. (III); 11:20 p. m. (V); 2:30 a. m. (III),
and 6:30 a. m. (I);
Four shocks at Los Angeles, Cal.—U. S. W. R.
1878. July 2; 5h. 55m. 30s. (a. m. or p. m.?) III.
Two light shocks at Campo, Cal.—U. S. W. R.
1878. July 26; 8:25 a. m.
Los Angeles, Cal., San Gorgonio.—C. G. R.; and San Bernardino.—
Fuchs.
1878. September 7; about 9:35 a. m.
Three shocks at San Francisco, Cal.—U. S. W. R.
1878. September 7; 11 a. m.
Severe earthquake in the southern portion of Humboldt County,
Cal.—B. Ms.
1878. September 29; 6 p. m.
San Francisco and Oakland, Cal.—C. G. R.
1878. October 11; 7:30 p. m.; V.
A severe shock at San José, Cal.—U. S. W. R.
1878. October 21; 5:40 p. m.
Two shocks at Sacramento, Cal.—U. S. W. R.
1878. November 11; 9:45 a. m.; III.
A slight shock at San Francisco, Cal.—U. S. W. R.
1878. December 9; 3:20 p. m.; V.
A severe shock at Red Bluff, Cal.—C. G. R.
1878. December 17; 4 p. m.
Two shocks at Campo, Cal.—C. G. R. Also Yuma, Arizona.—Fuchs.
1879. ?
Portland, Oregon.—P.
1879. February 4; Oh. 8m. a. m.
A shock at Visalia, Cal.—C. G. R.
1879. February 19; a few minutes after 5 a. m.
San Francisco, Cal.—C. G. R.
1879. May;
?—B. Ms.—*Esmeralda Herald*, May 31, 1879.
1879. May 26; 8:40 p. m.
Princeton, Colusa County, Cal.—U. S. W. R.

1879. August 10; 1:15 p. m.

A very light shock at Los Angeles, Cal. (II). Tidal wave at Santa Monica. Quite severe shock at San Fernando (IV? V?).—C. G. R.

1879. August 18;

A shock at Fiske's Mills, Sonoma County, Cal.—C. G. R.

1879. October 2; 6:30 a. m.; V.

Oakland, Cal., and round the bay, "a sharp shock."—C. G. R.

1879. December 7; 8:15 p. m.; III.

A slight shock at Los Angeles, Cal.—U. S. W. R.

1879. ? ?

There was a smart shock in Portland, Oregon—and only two or three shocks have been felt since that time.—Communicated by Geo. J. Ainsworth, Esq.

1880. January 9; 5:45 a. m.

Santa Cruz, Gonzales, and Hollister, Cal.—C. G. R.

1880. March 21; 6:25 a. m.; V.

A heavy shock, Los Angeles, Cal.—U. S. W. R.

1880. March 25; 2:30 a. m.; IV.

Moderate shock, San Gorgonio, Cal.—U. S. W. R.

1880. April 12; 4:40 a. m.; V.

Severe shock at Los Angeles; most severe on San Gabriel River; 4:30 a. m. sharp shock at Riverside, San Bernardino County.—*S. F. Chronicle*, April 13, 1880.

1880. April 12; 8:03 a. m.; V.

Severe shock at San Buenaventura, Ventura County, Cal.—*S. F. Chronicle*, April 13, 1880.

1880. April 14; 1:05 p. m.; V.

Strong shock, San Francisco.—C. G. R. Oakland.—B. Ms.

1880. May 5; 11 p. m.; IV.

Slight shock, San Francisco, Cal.; 11:35 p. m., San José.—C. G. R.

1880. June 24; 12:47 a. m.

San Francisco, Cal.—U. S. W. R.

1880. August 22; 1:25 p. m.

Southern part of Vancouver Island and northwest part of Washington Territory.—Fuchs.—C. G. R.

1880. August 29; 1:10 p. m.; III.

A slight shock, San Diego, Cal.—U. S. W. R.

1880. **September 26; 5:40 p. m.**
Los Angeles, Cal.—U. S. W. R.
1880. **November 4; 7:37 p. m.**
Sharp shock at San Francisco, Cal. (V). Felt slightly at San José (III).—C. G. R.
1880. **November 6;**
Newcastle, Cal.—Fuchs. Newcastle, Ontario.—C. G. R.
1880. **November 12; 8:45 p. m.; III.**
Slight shock at Los Angeles, Cal.—C. G. R.
1880. **November 12; 10:30 p. m.**
Santa Barbara, Cal.—C. G. R.
1880. **November 21; 8:10, 11 p. m., and 2:30 a. m.; or 7:45, 9:45, and 11 p. m.**
Los Angeles, Cal.—C. G. R.
1880. **December 7; 5:54 p. m.**
Olympia, W. T.; also at Bainbridge Island, W. T.—C. G. R. Dec. 6 (IV).—P.
1880. **December 10; 5 a. m.**
Bainbridge Island, W. T. "Vertical shock."—U. S. W. R.—Puget Sound (IV).—P.
1880. **December 12; 8:40 p. m.**
Severe shock near Puget Sound, W. T., from Victoria to Portland.—C. G. R. (VII).—P.
1880. **December 14; 7 p. m.; III.**
Slight shock was felt at Bainbridge Island, W. T.—U. S. W. R.
1880. **December 19; between 2 and 3 a. m.; V.**
Los Angeles, Cal. 3:40 p. m., from Los Angeles to San Diego.—C. G. R.
1880. **December 20; 11:16 p. m.**
Bainbridge Island, W. T.—U. S. W. R. Puget Sound (IV).—P.
1880. **December 21; 11 p. m.; V.**
Sharp shock at San Diego and Campo, Cal. 3:22 a. m., Campo, Cal.—C. G. R.
1880. **December 26; 2:30 p. m.; III.**
Tecaluma, San Diego County, Cal. "Slight."—U. S. W. R. [Marin Co.?]
1880. **December 28; 11 p. m.; V.**
Severe shock, Tecaluma, Cal.—U. S. W. R.

1880. December 29; 11:25 p. m.; III.

Slight shock, Bainbridge Island, W. T.—U. S. W. R.

1881. January 1; 6:55 p. m.

Red Bluff, Cal.—U. S. W. R.

1881. January 5-7; III.

Bainbridge Island, W. T. Slight shocks at 10:56 p. m. of 5th. Slight shocks 4:20 p. m. of 6th. Slight shocks at 10:15 p. m. of 7th.—U. S. W. R.

1881. January 6; 6:25 p. m.

Red Bluff, Cal.—U. S. W. R.

1881. January 7; 6:15 a. m.; III.

Slight shock, Campo, Cal.—U. S. W. R.

1881. January 16; 11 p. m.

Slight shock, Bainbridge Island, W. T.—U. S. W. R.

1881. January 24; 8:54 p. m.; 9:15 p. m.; 11:15 p. m.

Three shocks, San Francisco and Oakland, Cal.—C. G. R.

1881. January 30; 9:45 p. m.; III.

Slight shock, Bainbridge Island, W. T.—U. S. W. R.

1881. February 1; 4:11 p. m. (three shocks); 9:53 p. m. (two shocks).

Visalia, Cal.—U. S. W. R.

1881. February 2; III.

Slight shock at Salinas City, Cal.—U. S. W. R.

1881. February 14; about 1 o'clock; III.

Slight shock at Ukiah, Cal.—C. G. R.

1881. March 14; 10:30 p. m.; III.

Slight shock at Bainbridge Island, W. T.—U. S. W. R.

1881. April 10; 2 a. m.-2:15 a. m.; V.

Several severe shocks in Central California.—C. G. R.

1881. April 27; 9:10 p. m.

Los Angeles, Cal.—U. S. W. R.

1881. May 14; 13h. 9m.; IV.

Slight shock at Berkeley, Cal.—*Trans. Seismol. Soc. of Japan*, vol. x, p. 95.

1881. June 30; 8 a. m.; V.

Sharp shock at Campo, Cal.—U. S. W. R.

1881. July 2; 11 p. m.

San Juan, San Benito County, Cal.—C. G. R.

1881. July 3; 2:10 a. m.; V.

Heavy shock at Hanford and Visalia, Cal.—C. G. R.

1881. August 30; 7 p. m.; III.

Two slight shocks at Santa Barbara, Cal.—U. S. W. R.

1881. September 18; 5:20 p. m.

Severe shock at San Francisco, Cal. (V).—C. G. R. Angel Island (III).

1881. October 2; 9 a. m.; V.

Sharp shock, Campo, Cal.—U. S. W. R.

1881. October 21; 6:41 p. m.

Carson (Nev.), N. and S., two light shocks.—C. W. F.

1881. October 31; 4:10 p. m.; III.

Slight shock, San Francisco, Cal.—T. T.

1881. November 9; 10:08 a. m.

Carson (Nev.), N. and S., sharp shock, lasting two seconds.—C. W. F.

1881. November 11; 4 p. m.; III.

Slight shock, San Francisco, Cal.—U. S. W. R.

1881. November 13; 11:15 p. m.; V.

Smart shock, San Francisco, Cal.—T. T. 11.20 p. m.—U. S. W. R.

1881. November 15; at noon; V.

San José, Cal.—C. G. R. "Severe."

1882. January 28; evening; V.

Two severe shocks, Centerville, Cal.—C. G. R.

1882. February 3; 2:40 a. m.; IV.

Sharp shock, San Gorgonio, Cal.—U. S. W. R. "Direction doubtful."

1882. March 6; 2 p. m.; V.

Successive shocks at Merced; 1.57 p. m., two severe shocks at Santa Cruz; 1.45 p. m., two severe shocks at Gilroy; 1.45, one severe shock at Monterey; 1.47½, severe shock at Watsonville.—B. Ms. *S. F. W. Call*, March 9, 1882.

1882. March 11; 3:30 p. m.

Poway, San Diego County, Cal.—C. G. R.

1882. March 11; 4 p. m.; III.

Slight shock, San Diego, Cal.—C. G. R. 4.25 p. m.—H. Ms.

1882. March 16; 1:46 p. m.; III.

Light shock, San Francisco, Cal.—U. S. W. R.

1882. March ?; III.

Two slight shocks in Salinas, Cal., during the month.—Fuchs.

1882. April 13; 6:30 a. m.; V.

Sharp shock, San Francisco, Cal.—U. S. W. R.

1882. April 30; 10:48 p. m.; IV.

Two shocks, Portland, Oregon.—C. G. R.—P.

1882. May 1; 12:25 a. m.

Portland, Oregon.—Fuchs.

1882. June 27; 5:22 a. m.

Two severe shocks, four seconds apart, San Francisco, Cal. (V).—C. G. R. Also Petaluma, Hollister and Stockton.—Fuchs.

1882. July 15; 7:45 p. m.; V.

Sharp shock, San Francisco, Cal.—C. G. R. Heavy shock at Centerville, Alameda County.—H. Ms.

1882. July 22; 11:08 a. m.; II.

Very light shock at San Francisco, Cal.—U. S. W. R.

1882. July 31; about noon; III.

Light shock at Cape Mendocino, Cal.—U. S. W. R.

1882. August 8; III.

Light shocks at Oakland, Cal.—U. S. W. R.

1882. August 9; 8:45 p. m.; III.

Light shock at San Francisco, Cal.—U. S. W. R.

1882. August 13; night; VI or more severe.

Seven shocks at Round Valley, Inyo County. Two shocks between 12 and 1, night, were very severe.—H. Ms.

1882. August; twice during the month.

Salinas, Cal.—U. S. W. R.

1882. September 30; 10:57 a. m.; V.

Sharp shock at Campo, Cal.—U. S. W. R.

1882. October 8; 2 a. m.; V.

Heavy shock at San Diego, Cal.—C. G. R.

1882. October 20; 2:15 a. m.

Severe shock at San Francisco, Cal.—C. G. R.

1882. October 20; 3:10 a. m.; V.

Sharp shock in San Francisco, Cal.—T. T.

1882. October 31; 6:45 p. m.

Sharp shock, San Francisco, Cal. (V); felt, also, at Sonoma, Napa, Petaluma, and San Rafael.—C. G. R.

1882. November 11; 7:30 a. m.; V.

Severe shock at Mendocino.—H. Ms.

1882. December 19; 11:45 p. m.

Two light shocks, Visalia, Cal. (IV).—U. S. W. R. Bakersfield, two shocks at 11.30.—H. Ms.

1883. January 23; 5h.; III.

Slight shock, Los Angeles, Cal.—U. S. W. R.

1883. January 23; 11:40 p. m.

Light shock in San Francisco, Cal.—T. T. Sharp shock.—U. S. W. R.

1883. February 6; 16h. 30m.; III.

Slight shock, San Diego, Cal.—U. S. W. R.

1883. March 21; shortly before 1 a. m.; V.

Centerville (Alameda County), severe.—H. Ms.

1883. March 21; 4:30 a. m.; V.

Mendocino.—H. Ms. (Sleepers waked.)

1883. March 30; 7h. 48m., 7h. 52m., Sh. 15m.

Three shocks, San Francisco, Cal. (IV); nine shocks, Watsonville.—

C. G. R. Light shock, S. F., 8.10 a. m.—T. T. 7.39 a. m. at Hollister (VI); very heavy shock, windows broken, etc.—H. Ms.

March 30. 7.45 a. m.; Santa Cruz, three shocks (VI). 7.42 a. m.; Watsonville, violent shocks, nine in all (VI); pendulum clocks were stopped. 7.35 a. m.; San Luis Obispo. 7.50 a. m.; Centerville, three shocks. About 8 a. m.; Mission San José, several sharp shocks (V). 7.40 a. m.; Gilroy (V), glass broken. 8 a. m.; Martinez, two shocks. 7.40 a. m.; Salinas. 7.45 a. m.; Monterey.—H. Ms.

1883. April 2; Sh. 50m.; IV.

Two light shocks, San Francisco, Cal.—U. S. W. R.

1883. May 10; night.

Victoria, B. C. (III).—C. G. R.

1883. June ?;

Tacoma (III).—P.

1883. July 1; 3 a. m.

Carson (Nev.), light.—C. W. F.

1883. July 7; 10h. 50m.; II.

Light shock at Los Angeles, Cal.—U. S. W. R. (Direction?)

1883. July 30;

Two shocks, Gilroy, Cal.—C. G. R. July 31?—Fuchs.

1883. August 4; 11h. and 12h. 50m.

Two light shocks at Oakland, Cal.—U. S. W. R.

1883. August 19; 2:55 a. m.

Carson (Nev.). Three light shocks.—C. W. F.

1883. August 27; 1h.

Prof. Davidson reports earthquake waves at Saucelito.—C. G. R.

1883. August 31;

Los Angeles.—H. Ms.

1883. September 1; Sh. 25m.; III.

Light shock, Los Angeles, Cal. A second shock four seconds later.—U. S. W. R.

1883. September 5; 4h. 30m.; VI.

Shocks at Los Angeles, Santa Barbara, Wilmington, and San Buenaventura, Cal.—C. G. R.

1883. September 13; 14h. 30m.; IV.

Santa Barbara, Cal., lasting 5 seconds.—U. S. W. R.

1883. September 28; about midnight.

Two shocks, Portland, Oregon.—C. G. R.—0h. 0m. 10s., Portland.
Two shocks.—P.

1883. October 8? or 9?

6.45 p. m., light shock at Salinas (III); 7.50 p. m., much stronger at Salinas (V); 9.45 p. m., another at Salinas; Santa Cruz (V), a severe shock.—H. Ms.

1883. October 9; 23h. 3m.; IV.

Two light shocks, San Francisco, Cal.—C. G. R.

1883. October 10; 1:05 a. m.; V.

Sharp shock in San Francisco.—T. T. Heaviest since 1868.—B. Ms.
Not felt at Sacramento. Severe at Gilroy and Port Costa.—H. Ms.
Davisville reports a severe shock; Berkeley; Oakland.—H. Ms.
Detaille (*L'Astronomie*, 1885, p. 188).

1883. October 16; 3h. 15m.

A slight shock at Cape Mendocino, Cal.—U. S. W. R.

1883. October 22; 6 a. m.; VIII or more severe.

South side of the Merced River, below Merced Falls; a shock threw a section of the bluff two hundred feet by sixty by eighty feet, into the river. A sharp shock a few minutes before midnight.—H. Ms.

1883. October 24; 16h. 14m.; VI.

A severe shock at Cape Mendocino, Cal.—U. S. W. R.

1883. October 30; in the morning; III.

Two light shocks at Oakland, Cal.—U. S. W. R. Light shock at S. F.
—T. T.

1883. November 11; 18h. 15m.; III.

Slight shock at Poway, San Diego County, Cal.—U. S. W. R.

1883. December 3; V.

Severe shock at Shasta, Cal.—H. Ms.

1883. December 12; 23h. 40m.; III.

A slight shock at Los Angeles, Cal.—U. S. W. R.

1883. December 12; 1:50 a. m.; V.

Heavy shock at Salinas, Cal.—H. Ms.

1883. December 13;

Los Angeles, Cal.—U. S. W. R.

1883. December 16?; 15h.

A slight shock at Poway, San Diego County, Cal.—U. S. W. R.

1884. January 3; 20h. 40m.; IV.

A light shock, Portland, Oregon.—U. S. W. R. One shock.—P.

1884. January 4; 11h. 56m.; III.

Very light shock, Los Angeles, Cal.—U. S. W. R.

1884. January 25; I.

Professor George Davidson, of the U. S. C. S., reported from San Francisco that at 19h. 24m. earthquake waves were indicated by the levels of the astronomical instruments of the observatory, and they continued for twenty minutes.—C. G. R.

1884. January 27; 23h. 30m.; VII.

Moderate earthquake in Humboldt County, Cal. A second shock five minutes later.—C. G. R. (Eureka, Hydesville, Cape Mendocino.)

1884. March 15; 3h. 7m.; III.

Very light shock, San Francisco, Cal.—C. G. R.

1884. March 25; 4:40 p. m.

Severe shock, San Francisco, Cal. (VI). At 5.17 another less severe, Oakland and Berkeley (VI). Shocks felt from Santa Cruz to Petaluma.—Fuchs. 4.44 p. m.—T. T. Professor Davidson gives times of three shocks. At Gilroy, severe shock (VII); at Centerville, light (IV); at Santa Cruz, severe (V); at Petaluma, quite

severe (V); at Redwood City, quite severe (V); Mission San José, two heavy shocks (V); Spanishtown, severe (V); San José; Grass Valley.—H. Ms.

1884. April 6; 6h. 20m.; III.

A very light shock at Eureka and Hydesville, Humboldt County, Cal.—C. G. R.

1884. April 8; III.

In the morning very light shocks, Eureka, Cal.—U. S. W. R.

1884. April 11; III.

Light shock, Eureka, Cal.—Fuchs. Carson (Nev.), 2.10 P. M., N. W. and S. E. (IV), vertical shock.—C. W. F.

1884. April 17; 21h. 10m.; IV.

Light shock at Oakland, Cal.—U. S. W. R.

1884. April 20; 11h. 30m.; III.

A very light shock at Oakland, Cal.—U. S. W. R.

1884. June 6; 1h.; VII.

Two strong shocks were felt at Red Bluff, Cal., with an interval of three or four seconds.—C. G. R. (Walls cracked.)

1884. June 12; 8h. 48m.

A strong shock is reported by Captain C. F. Swan to have been felt at sea, in latitude $40^{\circ} 24'$ north, longitude $125^{\circ} 50'$ west, being about seventy-five miles west of Cape Mendocino, Cal.—C. G. R.

1884. June 18; 10h. 48m.

Los Angeles, Cal.—U. S. W. R.

1884. July 15; about daylight; III.

A very light shock at San Francisco, Cal.—U. S. W. R.

1884. August 2-3; in the night; III.

A very light shock at Santa Barbara, Cal.—U. S. W. R.

1884. August 8;

Lower Lake, Lake County, Cal. Shocks day and night.—H. Ms.

1884. August 4; 1h.; III.

Three very light shocks at Santa Barbara, Cal.—U. S. W. R.

1884. September 21; between 22h. and 23h.; III.

Light shocks were felt at New Tacoma, W. T.—U. S. W. R.—22h. 30m., Tacoma.—P.

1884. September 26; 10:53 p. m.; III.

Light shock at Yuma, Arizona.—Fuchs.

1884. September 27; 3 a. m.; III.

Light shock at Yuma, Arizona.—Fuchs.

1884. October 22; 15h. 34m.; III.

A light shock at Los Angeles, Cal.—U. S. W. R.

1884. November 4; 18h.

Three shocks 150 miles off Cape Mendocino, Cal., followed a few hours later by two heavier ones.—U. S. W. R.

1884. November 9;

Three earthquakes at Hollister, Cal.—A. S.

1884. November 12;

The self-registering tide gauge at Saucelito, Cal., recorded a series of waves probably due to a submarine earthquake.—C. G. R.—*San Francisco Evening Bulletin* of December 13.

1885. January 26; 1h. 33m., 120th meridian time.

A moderate earthquake (V) occurred in Central California from San Francisco, northward, to Napa and Petaluma.—U. S. W. R. Sharp shock, 1.32.—T. T. San Francisco (V); San Rafael (V); Oakland (V).

1885. January 26; 8:57 p. m.; IV.

Light shock in San Francisco, Cal.—T. T. Light shock (IV) Central California.—C. G. R.

1885. January 30; about 10:45; VIII.

Honey Lake Valley, Lassen County, Cal. Shock lasting over a minute; breaking glass and throwing down chimneys. In the ten days preceding February 8th, probably over one hundred distinct shocks have been felt. Shocks were most severe about Janesville, and on Susan River, twelve miles from Susanville.—H. Ms. See Feb. 26.

1885. January 30; 9:40 p. m.

Shock twenty seconds long in Sierra County.—H. Ms. At Susanville the shocks lasted from 9 p. m. to 4 a. m. Thirteen shocks were felt in places in the valley.—H. Ms.

1885. January 30; 21h. 38m., 120th meridian time.

A very light shock (III) at Sacramento, Cal.—U. S. W. R.

1885. February 5; 23h.

A moderate shock (V?) at Geyser Springs, Sonoma County, Cal.—C. G. R.

1885. February 6; 2h.

A moderate shock (V?) at Geyser Springs, Sonoma County, Cal.—C. G. R.

1885. February 7; night; V.

Four severe shocks at Susanville.—H. Ms.

1885. February 22; 18h. 53m.

A very light shock (III) at Newcastle, Placer County, Cal.—C. G. R.

1885. February 26;

The earthquakes still continue in the vicinity of Susanville. One shock recently, it is said, shook down the curbing of a well. The shocks appear to be local, as none are felt one hundred miles from here. This locality is in Lassen County, in the extreme north-eastern part of the State.—(S. F. C.)—C. G. R.

1885. March 30; 28h. 56m., 120th meridian time; VI.

A strong shock (VI) in Central California, from San Rafael, Marin County, to Monterey, Salinas, and Hollister.—C. G. R. San José (VI).

1885. March 31; about 3h.

A very light earthquake (III) at Fall Brook, San Diego County, Cal.—U. S. W. R.

1885. April 2; 7h. 15m.

A very light shock (III) Sacramento, Cal.—C. G. R.

1885. April 2; 7h. 25m.

A light shock (IV) at Merced and Fresno, Cal.—C. G. R.

1885. April 3; 10h. 15m.; III.

Sacramento, 2 shocks.—C. G. R.

1885. April 7; 2h.

Santa Barbara and San Buenaventura, Cal.—C. G. R.

1885. April 7; 2h. 30m.; IV.

A light shock, Bakersfield, Kern County, Cal.—C. G. R.

1885. April 11; 20h. 5m., 120th meridian time.

A strong shock (VI), Central California.—C. G. R. Monterey, Salinas, Merced, and Stockton (VI); Marysville, S. Rafael, S. Francisco, Hanford and Keeler (III).

1885. April 18; shortly before midnight.

A moderate shock (V), Keeler, Inyo County, Cal.—U. S. W. R.

1885. April 25; 20h. 20m.

A very light shock (III), Hydesville and Blue Lake, Humboldt County, Cal.—C. G. R.

1885. May 3; 23h. 30m., local time.

A very light shock, Olympia, W. T. Light shocks continued until 1h. 30m. of the 4th.—U. S. W. R. (II). At intervals for 2 hours.—P.

1885. June 14; 3h. 14m., 120th meridian time; V.

A moderate earthquake, San Buenaventura, Ventura County, and Los Angeles and Cahuenga, Los Angeles County, Cal.—C. G. R.

1885. June 25; 20h. 30m.

A very light shock (III), Salinas, Cal.—U. S. W. R.

1885. June 27; 5h. 26m.

A light shock (IV), Olympia, W. T.—U. S. W. R.

1885.

Three earthquakes noted during the summer at Kono Tyee, Clear Lake, Cal., by R. S. Floyd, Esq.

1885. July 9; 1h. 20m. to Sh. 15m.

Five moderate earthquakes (V), Santa Barbara, Cal.—U. S. W. R.

1885. July 22; 19h.

A very light shock (III), Centerville, Cal.—C. G. R.

1885. July 23; 12h. 25m.

A moderate shock (VI), San José, Santa Clara County, and Centerville, Alameda County, Cal.—C. G. R. Gilroy and Sta. Clara (VI).

1885. July 31; 16h. 10m.

A strong shock (VII), Cloverdale, Sonoma County, Cal.—C. G. R.

1885. September 13; 4h. 34m.

A light shock (IV) in Southern California.—C. G. R.

1885. September 20; about 7 a. m.

San Diego.—H. Ms.

1885. October 9; Sh.

A moderate shock (V), Olympia, W. T.—C. G. R. (III).—P.

1885. October 10; between 1h.-2h.

Three very light shocks (III), East Portland, Oregon.—U. S. W. R.—1h. 30m. (II).—P. See 1886, October 13.

1885. October 16; 4h. 45m., 120th meridian time.

A light earthquake (IV) in Central California, very faint in San Francisco (II), light in San Rafael (III), and heavier in Napa and Santa Rosa (IV).—C. G. R.

1885. November 19; between 13h. and 20h.; I.

Earthquake waves were indicated on the coast survey tide-gauge at San Francisco.—C. G. R. And on the levels of astronomical instruments at intervals of 35m.—*Nature*.

1885. December 8; 22h. 40m., 120th meridian time.

A moderate shock (V) Puget Sound, W. T.—C. G. R.—22h. 40m., Tacoma.—P.

- 1885. December 8; 10:12 p. m.; V.**
Sharp shocks at Victoria and New Westminster, B. C.—H. Ms.—22h.—12m.—P.
- 1885. December 18; 0h. 30m.**
A very light shock (III) Tatoosh Island, W. T.—U. S. W. R.
- 1885. December 21; morning.**
Slight shock; Susanville (IV).—H. Ms.
- 1885. December 28; between 3h. and 4h.; V.**
Santa Cruz, Cal.—U. S. W. R. Two heavy shocks.—H. Ms.
- 1885. December 30; 9:45 a. m.**
Light and rattling shock in San Francisco, Cal. (III).—T. T. Around the bay.—C. G. R. Oakland; heavy at Napa at 9.51 (V); severe at Redwood (V) at 9.40; Vallejo Junction and Port Costa 9.46½; slight at Santa Cruz (III) at 9.45; severe at Petaluma (V), 9.47; severe at Martinez (V), 9.50; severe at San Mateo (V), 9.45.—H. Ms. Probably at San José.—E. S. H.
- 1886. January 28;**
San Francisco and vicinity.—A. S.
- 1886. May 24;**
Fresno, Cal.—A. S.
- 1886. May 25; 3 a. m.**
Two shocks, San Francisco, Cal.—H. Ms.
- 1886. May 26;**
Earthquake shocks felt in different parts of California.—A. S. Santa Cruz (four shocks); Irving (two shocks).—H. Ms.
- 1886. May 26; 12:17 p. m.; IV.**
Slight shock, San Francisco, Cal.—H. Ms. *S. F. Bulletin*, May 27, 1887; 0.16 p. m.—T. T.
- 1886. June 7; 1:32 p. m.; III.**
Light shock in San Francisco, Cal.—T. T.
- 1886. July 2; 0:10 a. m.; III.**
Light shock in San Francisco, Cal.—T. T.
- 1886. July 2;**
Stockton, Cal.—A. S.
- 1886. September 3;**
Earthquake shocks felt in several California towns.—A. S.
- 1886? October 13; a little after 8 p. m.**
Point Lighthouse, S. F., Cal.—*Report of L. H. Board* for 1885-6.

1886. October 15;

Fort Point Lighthouse, S. F., Cal., 9.59 p. m.; Mare Island Lighthouse, Cal., 10 hours, $\frac{1}{2}$ minute, p. m.—*Report of L. H. Board for 1885-6.* 10.05 p. m., S. F., Cal. (IV).—T. T.

1886. November 11; 7:11 p. m.; III.

Slight shock at San Francisco.—A. S.

1886. December 6; IV.

San Francisco; also Santa Cruz.—A. S.

1887. January 3; 4:29 p. m.

Humboldt Lighthouse, Cal.—*Report of L. H. Board for 1885-6.*

1887. January 8; 2:20 a. m.

Cape Mendocino Lighthouse, Cal.—*Report of L. H. Board for 1885-6.*

1887. January 11; 4:11 a. m.

Fort Point Lighthouse, S. F., Cal. Pigeon Point Lighthouse, Cal., 4 a. m.—*Report of L. H. Board for 1885-86.* 4.10 a. m., S. F., Cal.—T. T. Two shocks.—A. S.

1887. January 15; 10:58 p. m.

Point Arena Lighthouse, Cal.—*Report of L. H. Board for 1885-6.*

1887. January 19; 3:15 a. m.

Point Arena Lighthouse, Cal.—*Report of L. H. Board for 1885-6.*

1887. January 19; 10:25 p. m.

Mare Island Lighthouse, Cal.—*Report of L. H. Board for 1885-6.*

1887. January 31;

Sharp shock at Bakersfield, Cal.—A. S.

1887. April 24; night; II.

Slight shock recorded on seismometer of Lick Observatory.

1887. April 29;

Shocks in Walla Walla Valley, W. T.—A. S.

1887. May 3; II.

Slight shock recorded on seismometer at Lick Observatory.

1887. May 3; 2:48 p. m.

I have no record of this shock at Fort Yuma, but I assume it to have been felt there. In *Science*, 1887, May 20, p. 483, under the heading, *The Sonora Earthquake*, is a good account by G. E. Goodfellow, of the shock at Tombstone, Arizona. At this place there were loud detonations. The severe shaking lasted 10 seconds, the moderately severe about 20, and tremors a little over one minute. No building of any stability was damaged, and no person was

injured. The railroad track of the A. T. and St. F. R. R., at a point where it ran east and west, was thrown $4\frac{1}{2}$ inches out of line, the convexity looking south. The bend was 300 feet long. For 48 hours after the shock there were tremors. Miners 600 feet below the surface felt the shock severely and some became sick. Miners at 150 feet noticed the shock less. The area of disturbance is estimated at 1,200 by 600 miles. In Fronteras Valley, Sonora, old Mexico, and the neighborhood, the shock was destructive to houses and to human life. Fissures north and south were produced. The center is probably south of Fronteras. At San Bernardino Ranch, 90 miles southeast of Tombstone, all the houses were thrown down. There are extinct craters at this place.

1887. May 3;

Los Angeles. Tremor recorded on the magnetic instruments of the U. S. Coast Survey Observatory. Dr. Schott's determination of the time is 2h. 14.7m. p. m., P. s. t. (His report of June 20, 1887; copy furnished by U. S. Geological Survey.)

1887. May 4; II.

Slight shock recorded on seismometer at Lick Observatory.

1887. May 12;

Heavy shock at Petaluma.—A. S.

1887. May 23;

Severe shocks at Lakeport.—A. S.

1887. June 3; 2:48 a. m.

Carson (Nev.), S. W. and N. E. (VIII). Very severe, lasting 6 to 7 sec.; rotary motion, preceded by a noise like thunder. Stone and brick walls cracked, etc.

1887. June 9; 9:04 p. m.

Humboldt Light Station. Light shock.—*Letter from Naval Secretary L. H. Board.*

1887. June 18; 1:20 a. m.

Carson (Nev.), two light shocks.—C. W. F.

1887. June 24; 9:20 a. m.; V.

Cape Mendocino Lighthouse. A single heavy shock, stopping the clock at 9:20 a. m., and lasting two seconds. No damage was done.—*Letter from Naval Secretary L. H. Board.*

1887. June 24; 9:20 a. m.; VI.

Humboldt Light Station. Clock was stopped.—*Mss. of L. H. Board.*

1887. July 1;

Cape Mendocino L. H. 10:25 p. m. Light shock.—*Ibid.*

1887. July 6; 10h. 15m. 10s. p. m.; V.

Recorded on seismometer at Lick Observatory. Sudden shock lasting not more than five seconds. Direction northwest and southeast. Amplitude $\frac{1}{10}$ of an inch. The exact time of the shock was noted by Mr. J. E. Keeler.

1887. July 8; 4 to 7:30 p. m.

An examination of the Coast Survey tidal register for July, at Saucelito, shows that at 4 o'clock p. m. on the 8th of July a sharp earthquake wave entered the harbor of San Francisco. The waves gradually grew smaller, and disappeared at 7:30 p. m.—*S. F. Bulletin*.

1887. August 13; 3h. 17m. a. m.; VI.

"A very severe shock" at Point Pinos Light Station; duration of shock, eleven seconds.—*Letter of Naval Secretary L. H. Board*.

1887. August 13; 6:55 p. m., standard time.

Santa Cruz Light Station.—*Letter of Naval Secretary L. H. Board*.

1887. August 17; 4:01 a. m.; IV.

Slight shock at Fort Point Light Station, Presidio, San Francisco, Cal.—*Letter of Naval Secretary L. H. Board*. 3h. 57m. a. m., lasting three seconds.—*S. F. Bulletin*, August 18, 1887.—E. S. H. 4 a. m., San Mateo (IV).

1887. August 19; 1:02 a. m.

Berkeley, Cal.—Very distinct shock, S. E. to N. W., reported by Professor Soulé, University of California.

1887. August 24; III.

San Diego felt two slight earthquakes yesterday.—*S. F. Bulletin*, August 25, 1887.

1887. September 9; 3:58 p. m.; I.

Single shock in S. F., Cal. ? Somewhat doubtful.—E. S. H.

1887. September 19; III.

Mariposa; light earthquake accompanied by heavy rumbling noise.—*S. F. Bulletin*, September 20th.

1887. October 4;

Keeler, Cal., 2 shocks, 3.45, 3.46 and 3.49, standard time. W. to E.—U. S. Signal Service Observers.

1887. October 12; 12h. 55m. a. m.; V.

Recorded on seismometer at Lick Observatory. Not so heavy a shock as that of July 6th, but sufficient to waken sleepers. It was felt at Smith's Creek, at the foot of the mountain. Direction, northwest and southeast.

1887. October 18;

Large meteor, moving from east to west; with earthquake at Gilroy.—A. S.

1887. October 19; 6:17 a. m.; III.

Slight shock at San Francisco.—K. J. Petaluma, 6.15 a. m.—*S. F. Evening Post*, October 19th. Berkeley, Cal., 6.20 a. m.—Prot. Soulé. Vallejo, Napa County, 6.20 a. m.—*S. F. Chronicle*, October 20th.

1887. November 25; 4 p. m.; II.

Slight shock recorded on seismometer at Lick Observatory.

1887. December 3; 10:30 a. m.

At Point Arena Lighthouse.

1887. December 3; 10:55 a. m.; V.

Mendocino, Cal. A shock, ten seconds long, at 10.55; another, short and sharp, at 11.20. At Ukiah, the times are reported as 10.50 and 11.10. At Ukiah no damage was done, though some clocks were stopped. San Francisco papers of December 4th.

1887. December 4; 4:30 a. m.

Very slight tremor at S. F., Cal. (II).—E. S. H. At Haywards (VI) a sharp shock, waking many persons from sleep.—*S. F. Chronicle*, December 5, 1887. At 5 and 7 a. m., destructive shocks in Calabria, Italy.

1887. December 5; — a. m.; V.

A sharp shock at Petaluma.—*S. F. Chronicle*, December 7, 1887.

1887. December 6; 3 a. m.; V.

Severe shock at Mendocino, Cal.—*S. F. Chronicle*, December 7, 1887.

1887. December 6; between 6 and 7 p. m.

A very light shock in San Francisco, felt by several persons.—E. S. H.

1887. December 7; shortly after 7 a. m.; I.

Very light shock, San Francisco.—E. S. H.

1887. December 7; about 2:30 p. m.; I.

Very light shock, barely strong enough to be recorded on the seismometer of the Lick Observatory.

1887. December 16; 4:15 a. m.

Point Arena Lighthouse, 3 severe shocks (probably VIII).

1887. December 16; 4:28 a. m.; 8:40 a. m.

Mendocino, Cal., two shocks.—*Oakland Enquirer*, December 16.

1887. December 25; midnight; V.

"Quite a violent shock" at Santa Rosa, Cal.—*S. F. Chronicle*, Dec. 27, 1887.

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Walla Walla (W. T.), December 9, 1887.—Several years ago a loud explosion somewhere in the Salmon River Mountains shook the whole country there, and reports of a volcano breaking out and lava flowing over the mountain trails astonished the country. The San Francisco *Chronicle* and Portland *Oregonian* sent reporters there, but neither could find any trace of a volcano, though whole forests were ablaze. Joseph Baker, of Mount Idaho, an old miner, reports to the Walla Walla *Statesman* to-day that he has discovered the scene of the explosion, near some new diggings. The country for half a mile around is full of fissures newly cracked, but there are many others covered with moss, denoting previous explosions.—*S. F. Chronicle*, December 10, 1887.

The place is only twenty miles from Mount Idaho.—*W. W. Statesman*, December 9.

1879 to 1887.

I am informed that between the building of the narrow-gauge railroad through the Santa Cruz Mountains (1879) and 1887, October, there has never been any damage to the tracks from landslides, etc., which has been attributed to earthquakes. This would show conclusively that no very severe shocks have occurred.—E. S. H.

1871-1887.

There has never been any damage to the roadbed of the narrow gauge railroad, from Saucelito to Russian River (Duncan's Mills), which has been attributed to earthquake shocks.—Verbal account of W. F. Russell, Esq.

EARTHQUAKES ON THE PACIFIC COAST, 1888.

1888. January 7; 10:25 p. m.

S. F. (II): Berkeley (IV).—at Berkeley a loud explosion.—Professor Kellogg.

1888. January 13; at night.

Berkeley, a slight shock (N. E. to S. W.) recorded on duplex seismometer (I? II? III?).—Professor Soulé. [Carson City, 7:33 p. m., S. W. to N. E.??]

1888. January 16; 11:39 p. m.

S. F.: single, short, sharp shock (IV).—E. S. H. (I have no other report of this, and it must therefore be regarded as doubtful.)

1888. January 17; 10:10 p. m.

S. F.—E. E. Barnard. Oakland, from N. E. to S. W. (III? IV?).—Professor Edwards.

1888. January 26?

Healdsburg, 10 sec. duration, *S. F. Chronicle*, Jan. 28. (Total eclipse of the moon on January 28.)

1888. January 29; 10:35 p. m.

Carson, Nevada, a slight shock (IV to V). Grass Valley, Cal.: the same shock (II).—*Grass Valley Tidings*, Feb. 3. Carson 10:45 p. m., S. W. to N. E. (III).—C. W. F.

1888. January 30; 4:15 a. m.

S. F. [not reported in newspapers.]—J. R. J.

1888. February 1; 4 a. m.

Point No Point Lighthouse, Washington. A slight shock.—Ms. kindly communicated by U. S. L. H. Board.

1888. February 18; 2:50 a. m.

Fort Bragg: three severe shocks (V?); the first at 2.50, the others at intervals of one or two minutes. Mendocino: three shocks; the first at 2.55, the others at intervals of three or four minutes.—(*S. F. Bulletin*, February 18.) Point Arena Lighthouse, 2.35 a. m., W. to E. A violent shock (VII?).

1888. February? about 4 a. m.

Menlo Park: sleepers waked (V or VI).—J. T. Doyle.

1888. February 29.

Mare Island Lighthouse, 2.50 p. m. Duration 2 seconds. Light shock. Point Reyes Lighthouse, 2.35 p. m. Severe shock (VII?). (Ms. communicated by U. S. Geological Survey.)

1888. February 29; 2:51 p. m.

S. F.: on Montgomery Street, people alarmed (V); Pine and Mason streets, more severe (VI); Washington and Mason streets (VI). Two waves on duplex seismometer (917 Pine Street). The motion of the earth was

a—N. 68° W. to S. 68° E. *b*—S. 56° E. to N. 56° W.

The shock *b* was most severe.

Berkeley: not felt, not registered.—Oakland: (II).—Belmont: not felt.—San Rafael: (IV or V) 2.48 p. m., E. to W.—Santa Rosa: 2.55 p. m., violent; people ran out of houses (VI).—Petaluma: 2.55 p. m., walls cracked (VII), sound of an explosion heard. The severest for many years.—Healdsburg: 2.44 p. m., light N. to S.—Martinez: 2.45 p. m., two shocks one minute apart (VI).—*S. F. Alta, Chronicle, Bulletin*, Feb. 29th and Mar. 1.

1888. March 7; 7:54 a. m.

Pasadena: 7.58 a. m. (VI); from N. W. to S. E., duration three seconds.—East Pasadena, 7.54 a. m., N. W. to S. E.—Los Angeles:

a little after 8 a. m. (VI)? "severest for 18 years; no damage to buildings," no very heavy articles overturned (VI). [Note: on 1883, Sept. 5th, a shock (VI) was felt at Los Angeles.—E. S. H.] —San Diego: scarcely felt (II). (*Pasadena Daily Star*; also *S. F. Alta, Chronicle*, Mar. 7, 8.)

1888. March 28; 1:41 a. m.

S. F.: slight shock, but sufficient to awaken a sleeper (V). Direction of shock nearly N. and S., on duplex seismometer, 917 Pine Street. Professor Davidson says duration $\frac{3}{4}$ second, and shock from W. to E.—*S. F. Bulletin*, Mar. 29.

1888. April 9; 7:50 a. m.

Riverside: slight shock (IV) N. E. and S. W. (*S. F. Bulletin*, April 9, *Chronicle*, April 10.)

1888. April 12; about 5:15 a. m.

Riverside: the shock sufficient to waken sleepers (VI), with loud noises accompanying. Colton, 5.30 a. m. (*S. F. Chronicle*, April 13.)

1888. April 13; 7:33 p. m.

Carson (Nev.), S. W. to N. E. Light.—C. W. F.

1888. April 28 [8:45 p. m.].

On the Lick Observatory seismograph an earthquake record was found April 29. From the trace of this shock the following data are taken. The dimensions given below are to be divided by 3.3 for the horizontal and by 1.6 for the vertical components, to get the actual earth movements. The times are given in seconds after a zero epoch arbitrarily assumed. The pen which marks the W. and E. components registered a line $\frac{1}{10}$ of a millimeter wide throughout. There appear to be widenings of this line as early as fifteen seconds before the zero adopted, but the amplitude of E. and W. tremors is never more than $\frac{1}{10}$ of a millimeter during the whole shock and the time of their beginning cannot be fixed. I presume we have here a case where the normal vibrations were strictly in an E. and W. plane. The transverse vibrations which arrived later are therefore N. and S. and of their full size in the diagram. We may then dismiss all further consideration of the E. and W. wave. It had scarcely a measurable amplitude. At 0 seconds the N. and S. tremors begin to show; the whole record of the vertical component is lost till 17 seconds.

At 3 sec. the earth moved S. of the neutral line 1 mm.

5	"	N.	"	1 "
6	"	S.	"	1 "
9	"	S.	"	1 "
10	"	N.	"	1 "

At 11 $\frac{1}{2}$ sec. the earth moved S. of the neutral line 1 mm.				
13	"	N.	"	1 "
15	"	S.	"	$\frac{3}{4}$ "
16	"	N.	"	$\frac{1}{2}$ "
18	"	S.	"	$\frac{1}{2}$ "
19	"	N.	"	$\frac{1}{2}$ "

and small tremors with a double amplitude of about $\frac{1}{2}$ mm. (on the trace) continue till 66 seconds.

The vertical component as recorded by the machine is given below:

At 18 sec. the earth moved above the neutral line 1 mm.

19	"	below	"	$\frac{1}{2}$ "
21 $\frac{1}{2}$	"	above	"	$\frac{1}{2}$ "
23	"	below	"	1 "

and tremors of not more than $\frac{1}{2}$ mm. continue on the trace till about 56 seconds.

We may assume for a basis of computation:

Number of waves in 10 seconds = 4.

Period, about 2.5 seconds = T.

Amplitude magnified, 1 mm. a = 0.3 mm.

Velocity of projection = $V = \frac{2\pi}{T} = 0.75$.

Intensity = $\frac{V^2}{a} = 1.90$,

which corresponds to about I on the Rossi-Forel scale. The period of these waves is very slow.

1888. April 28; 8:48 p. m.

Reno (Nevada), a smart shock: three waves in 3 sec., followed by a general trembling for 10 sec. The time of the third and severest shock was 8h. 48m. 38s. p. m. Direction S. to N. (letter from U. S. Surveyor-General Irish). Two other observers say W. to E.—Grass Valley: felt in the Idaho mine below the 1600 ft. level, *Alta*, May 2d. Very heavy, lasting 5 sec., from E. to W. (*Chronicle*, April 30).—Grass Valley: the Orleans mine was flooded. The shock was at 8.45 p. m. and very heavy (VII). It was preceded by a loud noise. The duration was about 5 sec., and the wave was E. to W. Clocks stopped, plastering fell, and also tops of chimneys.—Nevada City: walls of courthouse cracked (VIII).—Wellington (Nev.), two slight shocks in quick succession, 8.55 p. m.—at Marysville, Downieville, Truckee, Colfax and Sacramento the shock was very strong (*G. V. Tidings*, April 30, May 2).—Nevada City: two severe shocks at 8.48 p. m. preceded by a deep rumbling sound. Direction N.—Dutch Flat: 8.46 p. m., severe from S. to N. People were badly frightened.—Stockton: four shocks at 8.40, from N. to S.—Dixon, 8.45 p. m.—Biggs: heavy shock "lasting 75 (?) seconds" [seven to five? E. S. H.], at 8.45 (VII), plastering cracked, etc.—Santa Rosa: slight shock at 8.45,

N. and S. (III).—Truckee: 8.47, duration two seconds (*S. F. Examiner*, April 29.)—Oroville: 8.45 p. m. Short, quick shock.—S. F. barely perceptible in third story of 917 Pine Street. No record on duplex seismometer in basement (I). Carson, 8.47 p. m., S. N., (IV), lasting 5 to 6 sec.—C. W. F.

1888. April 30; about 4 a. m.

Grass Valley: *Tidings*, April 30.—Downieville, 3.40 a. m., two light shocks (IV), (*S. F. Bulletin*, April 30).

1888. May 4; 1:55 p. m.

S. F., 917 Pine Street, decided shock, not registered on duplex seismometer, J. R. J.—S. F., slight shock (II) of a few seconds' duration (*Bulletin*, May 4).

1888. May 6; 9h. 42m. 22s. p. m.

Lick Observatory: sudden shock (III) E. S. H., preceded by a rumbling noise (Porcher). (Registered on duplex seismometer.)

1888. May 27; 1:50 a. m.

Carson (Nev.), S. N.; light, followed by quite a heavy shock 20 sec. later.—C. W. F.

1888. July 6.

Wellington (Nev.), 5.25 p. m. A slight shock.

1888. July 11; at night.

Susanville: slight shock (IV??), *S. F. Bulletin*, July 13.

1888. August 13.

Wellington (Nev.), 2.50 p. m. A slight shock.

1888. August 14; 9:57 a. m.

S. F., 917 Pine Street. Intensity (II) on R. F. scale. The duplex seismometer gives a looped trace on the plate (magnified four times) 7 mm. N. N. E. to S. S. W. (direction of first shock), 4 mm. at right angles to this.—Lick Observatory: direction on the plate N. N. E. The trace is a wavy line (magnified four times) 8 mm. long. N. N. E. and S. S. W. with six waves 1 mm. high at right angles to this. Probably the shock was nearly vertical here.

1888. September 10; 1:53 a. m.

S. F., 917 Pine Street: slight shock (II) not registered on duplex seismometer, J. R. J.—Oakland: slight shock, C. Burekhalter. Three shocks at 1.50 a. m. in quick succession, attended by noise; windows did not rattle (III?), Dr. Trembley. It waked sleepers in Oakland (V?), E. Booth.—Berkeley: slight.

1888. September 15?

Lick Observatory: the seismograph started at 6.15 a. m., but as the record was not like that of a shock, Mr. Keeler (in charge of the instrument) supposes the tremor which started the instrument to have been due to a high wind.

1888. September 17; 3:51 a. m.

Lick Observatory: The seismograph gives the following records (magnified 1.6 times for the vertical, 3.3 times for the horizontal components). At 3 seconds after an assumed zero second, the vertical component began its trace with a wave of period about $1\frac{1}{2}$ seconds. The amplitude (on the trace) is hard to estimate, but is probably not less than 5 mm. for the first semi-wave, then about 1 mm. for a full wave, and after this mere tremors until about 40 seconds. The N. and S. component (magnified) was as follows:

At 4.3 seconds the earth moved S. of the neutral line 5 mm.

5.7	"	N.	"	2
5.9	"	on to	"	—
6.1	"	N.	"	$2\frac{1}{4}$
6.4	"	S.	"	$1\frac{1}{2}$
6.9	"	N.	"	1
7.5	"	S.	"	$1\frac{1}{2}$
8.9	"	N.	"	$1\frac{3}{4}$

and tremors occasionally as large as $\frac{3}{4}$ mm. continued until about 40 seconds.

The E. and W. component (magnified) was as follows:

At 4.3 seconds there was strong movement of the earth west of about 3 mm.; this was followed by a wave of period about 1 second double amplitude 2 mm.; and this again by another of period $\frac{3}{4}$ second double amplitude 1 mm. After this tremors continue for about 30 seconds.

The strata of which Mt. Hamilton is composed lie at a high angle to the horizon and the direction of the stratification is nearer N. and S. than E. and W. The earthquake instruments are at the very summit of the mountain. This may account for the fact that (at least for the shocks so far observed) the vertical component is relatively large, and that the N. and S. component (in the general direction of the stratification) is usually far larger than the E. and W. component.

We may then assume as a basis of computation for this shock:

Number of waves in 10 seconds = 6 or 7, say $6\frac{1}{2}$.

Period, T, of the representative wave = 0.5 sec.

Amplitude of the representative wave (magnified) = 2.5 mm.
 $a = 0.8$ mm.

$$\text{Velocity of projection} = \frac{2\pi a}{T} = 10.0.$$

$$\text{Intensity} = \frac{V^2}{a} = 126.$$

This corresponds approximately to V-VI on the Rossi-Forel scale, according to the table in the *American Journal of Science*, June, 1888, p. 429, which was derived from Japanese shocks.

Chabot Observatory: the time of the shock is 3h. 50m. plus or minus one quarter of a minute (W. Ireland, Esq.). It is registered on the duplex seismometer plate as follows. The first motion (of the pen, magnified four times) is 2 mm. to the W., then follow several small tremors towards the S. E. The motion of the earth is of course in the reverse directions.—Lick Observatory, 3.51 a. m.: severe shock, lasting several seconds. Strong vertical component (VI to VII) observed by E. S. H. Also on L. O. seismometer.—Gilroy, sharp shock; Santa Cruz, heavy (*S. F. Call*, Sept. 18).—S. F., 917 Pine Street: very slight, no record on seismometer, J. R. J.

Santa Cruz Lighthouse. Duration about 3 seconds. A very light shock. (Ms. kindly furnished by the U. S. Geological Survey.)

1888. September 23; about 11:30 a. m.

S. F., 917 Pine Street; very slight shock, J. R. J.

1888. October 3: 12:52 p. m.

San Miguel, S. L. O. Co.: light shock, 2 sec. duration, N. to S. (III). Another at same place at 1.02 p. m., quite severe, N. to S., 4 sec. duration, no damage done (VI?), *S. F. Chronicle*, Oct. 4.

1888. October 4; p. m.

Paso Robles: slight shock.—*S. F. Report*, October 5.

1888. October 4; 11 p. m.

San Diego.—*S. F. Bulletin*, October 5.

1888. October 5; 4h. 41m. 30s. \pm 10s. a. m.

Chabot observatory: the shock was sufficient to waken a sound sleeper (VI). On the duplex seismometer plate the trace begins with a tremulous motion toward the W., followed by two sharp jerks to the S. The motion of the earth is contrary to the motion of the plate.

1888. October 23? 24?

Lick Observatory: During Mr. Keeler's absence the earthquake instruments were in charge of Mr. Hill. On October 23, at 6 p. m., I noticed that the earthquake instruments were in their usual state. I also noted at 9 p. m., October 24, that a shock had occurred previously. The clock dial of the earthquake clock is divided to 12 hours (instead of to 24 hours as it should have been), and there is an ambiguity of 12 hours in the time of the shock, which is either—

1888. October 23; 11h. 42m. p. m., or October 24, 11h. 42m. a. m.

The shock was sufficient to start the clock of the Ewing seismograph, but the plate did not move. The duplex seismometer plate shows a tremulous wave in the direction N. E. and S. W.

1888. October 24; 2:50 a. m.

East Oakland: (V) Mr. Blinn's Observatory. The duplex seismometer plate shows a trace from S. to N. in general direction. The first trace on the plate is that of a single wave about 2m. in amplitude (magnified four times) followed by small tremors.—Chabot Observatory: the plate of the duplex seismometer shows the first wave strongly towards the N. E. The trace of this wave (magnified four times) is a straight line 6 mm. long. This is followed by two waves of the earth as it regained its original position. The motion of the earth is contrary to that of the pen on the plate.

1888. October 25; in the night.

Mr. Blinn's Observatory. The duplex seismometer gives a tremor, and the general direction of the trace on the plate is S. E. to N. W.

1888. November 4; 3:36 a. m.

Lick Observatory (VI).—E. S. H. Mr. Barnard gives the time as 3h. 37 $\frac{1}{4}$ m., plus or minus $\frac{1}{2}$ m. The duplex seismometer gives a very complex knot of curves ending by a trace on the plate towards the S. W.

1888. November 18; 2:28 p. m.

S. F., 917 Pine Street: two shocks north and south (VII) registered on seismometer. Another light shock at 5.38 p. m.—J. R. J.—S. F., 2h. 26m. p. m. Sharp vertical shock, duration 4 seconds.—T. T.—San Rafael: 2.30 p. m., N. and S.—Oakland: 2.29 p. m.; one chimney fell (VII?).—Berkeley: 2.28 p. m.; duration 7 sec.; a third shock at 5.35 p. m. (*S. F. Examiner*, Nov. 19.)

Lick Observatory: not felt, not registered.—Chabot Observatory: 2h. 27m. 53s., very sharp shock; 3.30, slight; 5h. 37m. 20s., sharper than the second shock. The duration was 3 sec. The trace on the duplex seismometer is a very complicated circular knot of 5 to 6 mm. diameter (magnified four times) with a looped excursion of the pen toward the east 6 mm. from the center of the knot, and another straight one from the center to the W. S. W., also of 6 mm. All three shocks are on this single plate.—In Oakland no real damage was done. Two or three chimneys were overthrown and panes of glass were broken (VI, or VII?).—East Oakland: 2.29 p. m., N. to S., duration 2 sec.; 3.45 p. m., very light; 5.36 p. m., E. to W., duration 2 sec.—(*S. F. Bulletin*, Nov. 19).—Napa: 2.36 p. m., duration 10 sec.—*S. F. Chronicle*, Nov. 19.—Haywards, San Leandro, Niles; not felt.—Mr. Burekhalter.—Clear Lake: not felt.—Capt. R. S. Floyd.

It is also reported by Capt. Edmundson of the ship "Drumlanrig," that he found soundings of 35 fathoms, 35 miles S. W. of the Farallones where no shoal is now known to exist. It is supposed

by some that the shock of Nov. 18 may have produced this shoal which is not down on the charts.

East Oakland: Mr. Blinn's Observatory. The first shock was severe (VI), lasting about two seconds. The time was very approximately 2h. 27m. 57s. (Blinn). Mr. Ireland gives 2h. 27m. 54s. Trees and hedges were seen to move. A few light articles were overthrown, pictures were displaced, a clock was stopped (its pendulum was in the plane N. E. and S. W.); 5 chimneys were thrown down on 23d avenue; a noise was heard *after* the first shock. The second shock was (II) at 3.48 p. m. The duplex seismometer trace is a loop about 1 mm. in diameter. The third shock was (III) at 5h. 38m. 45s. p. m. The trace on the duplex seismometer begins in an ellipse 2 mm. E. and W., 1 mm. N. and S., and then there is a confused record of trembling 3 mm. N. W. and S. E. by $1\frac{1}{2}$ mm. at right angles to this.

1888. December 11; 3:29 p. m.

Lick Observatory: the shock was sudden and (IV) in intensity. Time by watch 3h. 28m. 59s.; by earthquake clock 3h. 29 $\frac{1}{4}$ m.—J. E. K. A humming noise was heard *after* the shocks. There were two such at an interval of 2 sec. The time of the last was 3h. 28m. 58s. plus or minus 3 sec.—E. E. B. Intensity (V), time 3.28.8.—E. S. H.

The duplex seismometer gives a record (magnified) beginning with a sharp straight trace to the N. W. 3 mm. long, then a straight trace to the N. E. $1\frac{1}{4}$ mm. long, then a straight trace to the N. W. nearly 2 mm. long, and at the end of this the pen has recorded a confused tremor in a space about 1 mm. square. The record of the Ewing seismograph is as follows: (The adjustment of the marking pen for seconds has been changed so that there are 95 beats of the pen to 1 min. of time.)

There are very slight *vertical* tremors for the first three beats; they then vanish completely. Their period is from $\frac{1}{8}$ to $\frac{1}{10}$ of a second of time; their double amplitude is not above $\frac{1}{10}$ of a millimeter.

The *east and west* vibrations last only for two beats, though the faintest perceptible tremor lasts until the twentieth beat after the beginning. Their greatest double amplitude is not above $\frac{1}{2}$ of a millimeter, and their period appears to be about $\frac{1}{2}$ a second.

The *north and south* vibrations are well marked. From the zero beat (beginning) until $1\frac{1}{4}$ beats there are marked tremors. From $1\frac{1}{4}$ beats to $4\frac{3}{4}$ beats vibrations having a double amplitude of about one-half a millimeter, and a period of about $\frac{3}{8}$ to $\frac{1}{4}$ of a second time. At the end of the 6th beat the marked tremors cease and a very faint tremor continues to the end of the 20th beat, and possibly to the end of the 33d beat. As a basis of com-

putation we may assume from the record of the north and south component:

Double amplitude magnified 3.3 times = 0.5 mm.

$$a = 0.08 \text{ mm.}$$

$$T = 0.3 \text{ seconds.}$$

$$v = \frac{2\pi a}{T} = 1.7. \quad I = \frac{v^2}{a} = 36.$$

This corresponds to about II on the R.-F. scale according to the paper cited above. The intensity was, however, IV or higher.

EARTHQUAKES ON THE PACIFIC COAST, 1889.

1889. January 19; 1:43 a. m.

Oakland: A slight shock recorded on the seismograph of F. G. Blinn (II).

1889. January 22; 7:51:58 p. m. (?)

Mount Hamilton: a very light shock suspected by C. B. Hill (I?). No record was found on the seismographs.

1889. February 6; 9:20 p. m.

Southern California: a distinct shock at 9.25 p. m., shaking buildings and causing people to run into the streets. Vibrations from north to south, lasting about ten seconds (VI). San Bernardino papers. Colton: Two distinct shocks at 9.20 p. m. Los Angeles: slight shock at 9.25 p. m. Shock accompanied by distinct dull rumbling. Post office clock at San Bernardino stopped at 9.20.30, subject to an error of five or six seconds (VI). The clock faced the east. W. C. Parmley, San Bernardino. At Kodiak Island earthquake waves were recorded from February 5, 9 p. m., to February 6, 7 a. m.

1889. March 16; 2 p. m.

Point No Point Lighthouse, Washington. A slight shock.—U. S. L. H. Board.

1889. April 3; 2:29 a. m.

Mount Hamilton: a slight record was made on the Ewing and duplex pendulum seismographs (II). The greatest motion was from north to south, a very slight motion from east to west, and the vertical component was imperceptible. The maximum (magnified) amplitude was about one-fourth millimeter, and the period of a vibration about two-thirds of a second; hence the computed intensity is 7.0 or (I) by the Rossi-Forel scale. This shock was not felt by anybody at the observatory. The time given is that recorded by the seismograph clock.

1889. April 14; 7:28 p. m.

Central California: Lick Observatory, time of ending 7.27.56 (E. S. Holden), 7.28 $\frac{1}{4}$ (E. E. Barnard). Felt by many persons at the observatory, but not by all. Recorded on both seismographs (III).

The curve representing the north and south motion on the Ewing seismograph begins with three quite regular waves of progressively diminishing amplitudes, the period of each being 1.25 seconds. The maximum (magnified) amplitude is 0.5 millimeter. The east and west curve begins with a series of small, irregular tremors, followed by two marked and fairly regular waves which begin about where the waves of the north and south curve end. Maximum (magnified) amplitude, 0.4 millimeter. The vertical motion is very slight. The marked vibrations on all the curves end at about ten seconds, but very slight undulations extend to about one and one-half minutes. It is hard to say how much of these is real. The intensity of this shock, computed from the data above given, is 4.0 or (I) of the Rossi-Forel scale.

San José, 7.27.30 (S. W. Burnham). San José, University of the Pacific: the record on the duplex pendulum seismograph at this place is considerably larger than that obtained at the Lick Observatory, and is very complicated. The *San José Times* says: "The shock was not severe, but was quite plainly felt by many people. A majority of people, however, were unconscious of anything unusual."

Santa Cruz: quite a severe shock, with quick, jerky motion from east to west, rattling the windows in loosely built houses. Time, 7.25. Probably the heaviest shock felt in Santa Cruz in four or five years, although many people on the first floor of well-built houses did not notice it.—*Santa Cruz Surf*.

An earthquake occurred at 7.30 p. m. The vibration was north and south and lasted several seconds.—*Dispatches from Santa Cruz*.

Centerville: slight earthquake at 7.34. Vibrations northeast to southwest.

Los Gatos: two slight but distinct earthquakes at about 7.15. Vibrations from south to north.

Gilroy: remarkably sharp but short earthquake at 7.25, making lamps, crockery, etc., rattle severely.

Merced: a heavy double-shock earthquake at 7.33. Oscillation, northwest to southeast, and about two seconds in duration.

Oakland: earthquake at about 7.28, not felt by all persons.—F. G. Blinn. The record on Mr. Blinn's seismograph shows about the same amount of motion as at the Lick Observatory.

1889. April 17; 8:32:38 p. m.

Mount Hamilton: noted by J. M. Schaeberle, while observing the collimation constant of the meridian circle. The wires vibrated through about 10 sec. Time noted, 8.32.40. Suspected in another part of the building by J. E. K. Time noted, 8.32.36. No perceptible record on the seismographs (I).

1889. April 17; 10h. 18m. p. m.

San Francisco: a slight shock, E. to W.

1889. April 20; 4 a. m.

University of the Pacific, San José: Prof Higbie sends a record obtained with his seismographs, showing a considerable disturbance. I have no other notices of this earthquake.

1889. April 24; 3:37 a. m.

San Francisco: "heavy earthquake shock occurred at 3.37 a. m. Vibrations from north to south."—Jenkins. Received at Washington Signal Office.

1889. May 1.

Lompoc: quite a heavy earthquake shock was felt here at 11.55 to-day. The vibrations were from east to west. No damage. Susanville: at 9 o'clock a sharp earthquake. The vibration was north and south.

1889. May 19; 3:10 a. m.

Central California: at the Lick Observatory nobody was awakened, although the motion as registered by the seismographs was considerable. This is probably owing to the long period of the vibrations. The time recorded by the earthquake clock was 3:9.6. The following letter was furnished by Prof. Holden to the California Associated Press:

Lick Observatory.—The earthquake was felt at the Lick Observatory at nine minutes past 3 o'clock this morning, as a series of gentle shocks of small amplitude and slow period. It was not severe enough to awake the sleepers. The extraordinary feature of this shock was its great duration, which is registered on our instruments for no less than two minutes and twelve seconds. In this feature it resembles the great Inyo shock of March 26, 1872, as experienced in San Francisco, and for a similar reason. The observing station was in both cases far removed from the origin of the shock, and the energy of the earthquake was manifested in long waves of slow period, but lasting for an unusual time. Moreover, in this case the shock was far more severe in Santa Clara Valley than after it had traversed several ranges of hills and reached Mount Hamilton. Our earthquake machine shows that the up and down movement lasted eighty-four sec-

onds. The period of each wave was about 1.7 seconds, which is very gentle and slow, and the double amplitude of the vertical waves was never more than 0.03 of an inch. The east and west movement consisted of strong tremors for nearly four seconds, when the waves began and lasted, as strong decided movements, for twenty-nine seconds, after which the tremors continued until their trace was lost. Ninety seconds after the beginning, the period of these waves is 0.8 of a second (very slow) and the double amplitude is about 0.03 of an inch. The most remarkable motions were in the north and south direction. The tremors were felt for three seconds, ten large waves for forty-five seconds, succeeded by tremors until one hundred and thirty-two seconds from the beginning. Their period was 0.6 of a second. The double amplitude is 0.05 of an inch. The duplex machine shows results agreeing with the above and indicates the very complex nature of the motion of the ground.

The vibration of greatest amplitude occurred only five seconds after the plate of the Ewing seismograph started, and is nearly as great in the east and west as in the north and south curve, while the vertical component is small. Paying due regard to the values of the different components, it appears that the maximum vibration (double amplitude) of the earth at the Lick Observatory was 2.2 millimeters, and the period being 0.6s. as stated above, the computed intensity of the shock is 120 or (V) of the Rossi-Forel scale.

Yerba Buena Island Light Station, San Francisco Bay; time, 3.14 a. m.: from eight to twelve seconds duration; one long, rolling shock with a sort of jumping motion also, but it still can only be called one shock; lighthouse clock did not stop; the motion was certainly from east to west; no damage.—J. A. F. McFarland.

Mare Island Light Station; time, 3.9.30 a. m.: observer was awakened. The shock was intermittent; door-bell rang in a house near by (VI).—Kate C. McDougal, light-keeper.

Berkeley: in the valleys the shock was more severe. The seismograph tracing of the university observatory at Berkeley shows a very complex curve, which can be roughly bounded by an ellipse 8 by 6 millimeters, with one great loop extending 7 millimeters farther (magnified four times). Duration 12 sec. Vibrations slow.

Oakland: the Chabot Observatory record has some resemblance to the above, but is larger, the bounding ellipse being 22 millimeters long, also with a loop extending toward the northwest. The mean-time clock of the Chabot University stopped at 3.01.44 (VI).—C. Burckhalter.

East Oakland: the record obtained at Mr. Blinn's observatory somewhat resembles that just described, and indicates a shock of

about the same intensity. Several loops extend about 20 millimeters from the center.

The shock lasted from five to twelve seconds, according to some persons, while others considered that the earth shook for fully a minute; motion great but gentle; two persons felt nausea; four regulators in jewelers' shops, on walls running west-northwest and east-southeast, stopped at about 3.10, two of them indicating 3.10.30 and 3.10.35 respectively. A clock with heavy mercurial pendulum on same wall was not stopped.—F. G. Blinn. Intensity = (VI).—William Ireland.

Three miles from Collinsville, in the region of greatest disturbance, houses rocked and pieces of plaster fell (VII); articles shaken from mantelpieces, etc.; chickens shaken from their perches; dogs barked; two chimneys demolished (VIII), and one had the upper part twisted 45 degrees; goods thrown from shelves in stores.—F. E. Booth, manager of Black Diamond Canning Company, in a letter to F. G. Blinn.

Mills College: in the seismograph record at this place there are great loops 80 millimeters long, which appear to have been produced by the swinging of the pendulum after the shock. It is necessary to give the seismograph pendulums some stability, but they are adjusted to swing in a long period, much longer than that of the ordinary earthquake shock. It is evident, however, that in an earthquake like this the vibrations might be nearly synchronous with those of the pendulum, which would thus be thrown into violent oscillations. In most earthquakes this is not likely to happen. Possibly the long loops in some of the other seismograph records may be due to the same cause.

San Francisco: No damage was done in the city. The newspaper accounts seem to be exaggerated. Motion from west-northwest to east-southeast.—J. B. Trembley.

Time of shock in San Francisco, 3.10.42.—Prof. Davidson.

Fort Point Light-Station: the shock was preceded and accompanied by a rumbling noise and lasted eight or nine seconds. The keeper felt three shocks, the first short and light, and about fifteen seconds later one more distinct; a minute afterwards, the last, which was a tremor. Doors were opened; windows and crockery rattled and people were aroused from sleep (VI?).

Lime Point Fog-Signal Station: time 3.10.32. Lasted about five seconds, and was accompanied with a noise like the rumbling of distant thunder.

Forest Hill: in the Mayflower mine no sign of an earthquake at 600 or 800 feet underground. Directly over the mine the shock was strong enough to rattle a wash-bowl against a pitcher.—S. E. Reamer, San Francisco.

San José, University of the Pacific: Prof. Higbie sends a record which shows about the same amount of motion as at Oakland, the greatest oscillations being northeast and southwest.

San Francisco: 3h. 15m. a. m. Sharp shock; rolling; duration 15 sec.—T. T. Various reports from the San Francisco papers are given below, the date being May 19.

At 3.12 a. m. Sunday morning a severe shock of earthquake was experienced here. It lasted twenty seconds and was followed by peculiar shivers continuing five seconds longer. The motion was from east to west, and the shock is said to have been the sharpest experienced here for the past fifteen years. Half of the door-bells in the city were set ringing, and glassware and mirrors damaged (VI).

Stockton: a heavy shock at 3.15 this morning. It lasted about ten seconds, with vibrations from north to south. A large number of people hurried into the streets. One man jumped out of a second-story window. A number of buildings were heard to crack, but no damage has been reported (VII).

Lodi: the heaviest earthquake that has been felt here for twenty years occurred at 3.15 this morning. The wave was north and south, and so severe that goods were shaken from shelves in one of the stores here, and dishes rattled in the houses.

Antioch: the most severe earthquake shock experienced since 1868 about 3.10 this morning. It shook off the tops of many chimneys in the town. The vibrations were from north to south. The entire population was aroused and many people in their night-gowns rushed into the streets. No serious damage is reported, but the harvest of broken crockery and glassware, cracked plaster ceilings and chimneys, is abundant (VII? VIII?).

Modesto: the people of this section were awakened by a heavy shock of earthquake at 3.15 this morning. The vibration was from north to south and lasted several seconds. The windows and doors rattled and chandeliers vibrated. A second shock, less pronounced, followed ten minutes later. No damage (VII).

Napa: the severest earthquake experienced here in twenty years occurred at 3.10 this morning. It lasted twelve seconds. No damage is reported beyond the cracking of plaster. The vibrations were from west to east (VII).

San Leandro: the heaviest shock of earthquake felt here for years at 3.11 this morning. The vibrations were from north to south and lasted about one minute.

Petaluma: this morning at 3.15 there were three distinct shocks. They followed each other in quick succession, the vibrations being from east to west. The second shock was exceedingly heavy.

Rio Vista: at 3.15 a. m. the most severe shock of earthquake since 1868, the duration of the shock being several seconds. People jumped from their beds, chickens were thrown from their roosts, and some chimneys were slightly damaged. The direction was from west to east (VII).

Newark: the most startling earthquake for many years was felt here this morning at 3.05. There appeared to be three shocks, vibrating from east to west.

Nevada City: three distinct and rather heavy shocks of earthquake were felt here this morning at 3.30. Their direction was from west to east.

Calistoga: an earthquake at 3.03 this morning. It was not remarkably heavy, but the vibrations, which were from east to west, continued longer than those of any earthquake felt in many years.

Vacaville: The shock this morning at 3.10 lasted fully half a minute. It was the most severe shock ever experienced here. The vibrations were from northeast to southwest.

Santa Cruz: quite a sharp shock was felt here at 3.20 this morning, vibrating from west to east.

Sacramento: an earthquake was felt here at 3.10 this morning. The wave came from the southeast and was quite severe. No damage.

Mountain View: a heavy shock, with vibrations north and south, was felt at 3.10 this morning. No damage.

San José.—The earthquake at 3.12 to 3.14 a. m., the wave seeming to pass from southeast to northwest. There was but one distinct wave, followed by a rumbling and a backward motion, due to the reaction.

Pleasanton: at 3.15 this morning the worst earthquake shock since 1868. The vibrations were north and south, and continued for fifteen seconds. They were so severe that buildings creaked and tottered (VII).

Haywards: a severe shock about fifteen minutes past 3 o'clock. It was strong enough to throw many out of bed, and lasted several seconds (VII? VIII?).

Los Gatos: three sharp earthquake shocks at 3 o'clock this morning. The first was much more severe than the two succeeding ones. The vibrations were north and south.

Fairfield: three heavy shocks in quick succession were felt here at 10 minutes past 3 o'clock this morning, vibrating east and west. They were the heaviest since 1868.

Woodland: there was quite a heavy earthquake this morning at 15 minutes past 3 o'clock. The vibrations were from east to west, and the duration about fifteen seconds.

Santa Rosa: three distinct shocks of earthquake in close succession were felt at 3 o'clock this morning. The vibrations were from east to west.

Ione: many citizens were aroused at 3.10 this morning by an earthquake shock, lasting several seconds. The vibrations were north and south (VI).

Suisun: at 3.10 this morning a severe shock of earthquake was felt here, accompanied by a rumbling noise.

1889. May 26; 7:13 a. m.

Central California.—Lick Observatory: a very slight shock was recorded by the seismographs at 7.12 ± 1 . The extreme motion of the earth's surface did not exceed 0.5 mm. The greatest disturbance was in a north and south direction, and the vertical component was very small. Although this shock was recorded on both instruments, it was not felt by any one on the mountain. Period = two seconds, hence computed intensity = 2.5 or (I). San José and vicinity: not felt.

San Francisco: 7h. 14m. a. m. Light shock, duration 1 sec.—T. T. A slight shock of earthquake was felt in this city on Sunday morning at thirteen minutes six seconds after 7. The vibrations lasted but two or three seconds and were east and west. (Time noted by Professor Davidson.)

Gonzales: a heavy shock of earthquake was felt here this morning at 7.15. The tremor lasted half a minute and made the large buildings quiver. The oscillation was from northeast to southwest.

Santa Cruz: quite a shock of earthquake occurred at 7.15 this morning, the wave being west to east. No damage was done, the shock being much lighter than the one a week ago.

1889. June 2; 5:54 p. m.

Humboldt Light Station: it lasted about seven seconds. No previous noises; but with the quake came a noise of rushing wind or sudden gust. I would class the quake as light. It rattled crockery, but did not throw anything off shelves. It indicated itself in an undulatory motion from west-southwest to east-northeast as marked by a wicker basket suspended from the ceiling which swung 15 degrees. The pendulum clock in light tower (pendulum 20 inches long) stopped at 5.54 p. m. sun time by almanac; the clock faces to west.—William C. Price, light-keeper.

1889. June 6; 4 a. m.

Oakland: a sudden shock lasting one second, followed by a rumbling noise lasting five or six seconds (II).—F. G. Blinn. A slight trace was made by the seismograph. Mount Hamilton—not felt or not recorded.

1889. June 6; 8:30 p. m.

San Bernardino: noticed by some persons, but not by all. A single shock from northeast to southwest, with some vertical motion. A few persons report rumbling noises. Times of occurrence vary somewhat; 8.14 given by one person. Estimated intensity (III). —W. C. Parmley. There was quite a shock of earthquake in this city last evening at about 8.30. The shock was accompanied by a low rumbling, and the vibrations were northeast to southwest. —San Bernardino, *Daily Times-Index*, June 7.

1889. June 9; 3:44:24 ± 3 p. m.

Mount Hamilton: very slight shock (I) noticed by J. E. Keeler, not by others. Vibrations lasted a few seconds. A small record was made on the duplex seismograph.

1889. June 10; 7:33:7 a. m.

Mount Hamilton: very slight shock recorded on both seismographs, but not felt by anybody (II). Measurement of the record on the Ewing seismograph gave the following data: Duration = twenty-four seconds; maximum double amplitude (magnified) east and west = 0.52 millimeter; maximum double amplitude (magnified) north and south = 0.38 millimeter; maximum double amplitude (magnified) vertical = very small; period of complete vibration = about one-half second. Hence computed intensity is 12 or (I) of Rossi-Forel scale.

1889. June 19; 10 p. m.

Lassen County, California, and Nevada: this shock, which does not appear to have been felt in the central and southern parts of California, is thus described in the *Susanville Advocate*:

Since the 19th instant the people of Susanville, Lassen County, have felt about seventy-five slight shocks of earthquake. The first shock occurred at 10 o'clock on the night of the 19th, and was the heaviest ever experienced in this section. The first great shock was followed at greater or less intervals by more or less heavy shocks for over two hours, until twenty-eight shocks had been recorded, of which the first, the thirteenth, the fifteenth, and the eighteenth were very severe. At the first shock, which was something fearful, rocking buildings from side to side and scattering crockery and glassware in all directions, people rushed out of houses with the costume, principally, that nature had provided for them (VII). The vibrations were from south to north, but apparently did not extend much north of Susanville. The shocks were generally preceded by distinct rumbling noises.

Chico: a slight earthquake shock was experienced here last evening about 10 o'clock. Vibrations from east to west.

Sacramento: at 10.12 last night a slight shock of earthquake was felt here. It lasted but a few seconds, and was felt by only a few persons.

Susanville: the heaviest earthquake ever felt here occurred at 10.05 last night, succeeded by lighter shocks at short intervals during the entire night.

Downieville: there was an earthquake last night at 10.07 lasting about a minute. The weather is warm. The mercury this afternoon marked 90 degrees.

Grass Valley: an earthquake was felt here at 10 o'clock last night. The shock was quite heavy.

The following is part of a letter to the *San Francisco Call*:

The series of earthquake shocks that commenced here on the evening of the 19th inst. have been continued at intervals up to the present. Although the first shock was by far the hardest, there have been a number since that have made things quite lively. Reports from different localities within a few miles of here point to the fact that this place, Willow Creek, and Eagle Lake appear to be the centers of the disturbances, the surrounding country being less disturbed. The section named above could be included in a circle twenty-five miles in diameter. Since the first shock some curious phenomena have been developed. The spring from which the town of Susanville is supplied with water has been largely increased in its volume of water, as also many others in this vicinity. The waters are of a milky whiteness. The water of Eagle Lake has been greatly disturbed and is quite muddy. At the south of Eagle Lake and extending many miles is a range of high volcanic hills. A number of persons who were near or on these hills last Friday heard loud rumblings to the west, accompanied by loud detonations like the firing of very heavy artillery, while the earth seemed to keep up an almost uninterrupted trembling motion. A slight trembling is also noticed much of the time here in town. A farmer in Willow Creek Valley, and who was at work in a large irrigating ditch at the time of one of the recent shocks, had the water thrown out of his ditch, so violent were the oscillations of the earth. A chimney in the house of S. Knudson, in Willow Creek, was thrown down by the first shock. (VII? VIII?).

San Francisco: news from Susanville in the Sierra Nevadas says slight earthquake shocks continue, and that the people have become so accustomed to the constant trembling of the earth that they pay no attention to it.—S. F. papers.

Carson City, Nevada: Prof. C. W. Friend sends a seismograph record which shows a maximum motion of 5 millimeters (magnified four times about equally distributed in all azimuths (10.00 p. m., S. N., light).

1889. June 20.

Sacramento: a shock.

Susanville: A continuation of the earthquake shocks. "There were earthquake shocks at intervals the entire day after the first heavy shock during the night. The upper heavens were filled with small meteors."—*S. F. Chronicle*, June 22.

1889. June 20; p. m.

University of the Pacific, San José: the seismograph record shows vibrations of about 3 millimeters in an east and west direction and 1.5 millimeters in a north and south direction (both magnified).

1889. June 24; about 4 a. m.

University of the Pacific, San José: the record sent by Prof. Higbie indicates a shock of about the same intensity as the preceding one, with vibrations in about the same direction.

1889. June 25; 3 a. m.

San Diego: "Dr. Eigenmann reports an earthquake at San Diego at 3 a. m., June 25."—*West American Scientist*, August.

Carson City, Nevada: a seismograph record, marked "during night, June 25-26," is sent by Professor Friend. The vibrations are west-northwest and east-southeast, and indicate a shock of intensity (III).

1889. June 27-28; during night.

Carson City, Nevada: a slight shock recorded, with vibrations in same direction as the preceding one.

1889. June 30; between 8 and 10 a. m.

Carson City, Nevada: (II) or (III).—C. W. Friend.

1889. July 2-3; during night.

Carson City, Nevada: slight shock recorded (II?).

1889. July 3.

Oakland: 4.45 a. m. and 5.02 a. m. and also 6.30 p. m.—Cal. S. W. Service Annual Review.

1889. July 4; 8:05 a. m.

Carson City, Nevada: slight shock recorded. About the same as the preceding.

1889. July 4-5; during night.

Carson City, Nevada: record larger than the last, but pen did not return to starting point. Magnified motion perhaps 3 millimeters.

1889. July 6-7; during night.

Carson City, Nevada: record shows (magnified) motion of 4 millimeters in direction west-northwest and east-southeast.

1889. July 9-10; during night.

Carson City, Nevada: slight shock. In all these records the principal motion is west-northwest and east-southeast.

1889. July 10; and preceding days.

Arroyo Grande, San Luis Obispo County: the following report is from the *San José Times*:

The territory around Los Olivos has been troubled with an earthquake the past few days. Sunday there were six distinct shocks, one of which rattled the dishes off the shelves. The hardest shock took place at 3 o'clock this morning. The druggist at Santa Ynez has removed his bottles from the shelves to the floor. Four years ago a burning volcano was reported at Lookout Mountain, on the south side of Santa Maria valley, which was decided to be a burning asphalt bed.

1889. July 25; 10:8 p. m.

Mount Hamilton: sharp shock. Rattled pictures on the wall. Time, 10:8.2 (V).—E. S. H. A light quivering shock, followed by a severe shock, shaking the observatory building, at 10.7.59.—E. E. B. Time, 10.7.59.—J. M. S. Time, 10.7.58.—C. B. H. Generally felt by those on the mountain who were awake and not engaged in some occupation which would disturb the attention. It did not seem to me as strong as others we have had (IV).—J. E. K.

Record obtained on both seismographs. The Ewing machine shows maximum (magnified) double amplitude = one millimeter in north and south direction, with period = one-third second. Corresponding east and west motion very small, and vertical component hardly perceptible. The vibrations are almost indistinguishable at fifteen seconds after the time of starting of the plate. The duplex pendulum record agrees well with this, but shows a slightly greater amplitude (magnified four times, about 2 millimeters). The computed intensity is 53 or R.F. (II-III).

1889. July 31; 4:46:45 a. m.

Central California, Mount Hamilton: shock wakened sleepers. Time 4.46.45 a. m. (V).—E. S. H. Awakened from sleep. Time, as nearly as could be ascertained, 4.46.50 a. m.—J. E. K.

Measurement of the record made by the Ewing seismograph gives the following data:

Extreme duration, 30 seconds.

Greatest motion, north and south (double amplitude), 1.3 millimeters (magnified).

Motion east and west, a little less.

Vertical motion very small.

Period of wave = about 0.3 second.

Computed intensity = 88 = (IV +).

The duplex pendulum seismograph gave a record in close agreement with the above.

Mare Island Light Station: time 4.48, navy-yard time.—Was awakened from a sound sleep. There was a rattling of bowls and pitchers. I felt two shocks; that is, one that was continuous and a sudden heavier impetus in the midst of the general shaking. It was sharp, severe, and quick, and more vertical than that of May 19.—Kate C. McDougal, light-keeper.

Santa Cruz Light Station. Time, 4.45 standard time.—One tremulous shock lasting about three seconds.—Laura J. F. Hecox, light-keeper.

Fort Point Light Station. Time, 4.47.—One shock lasting about twelve seconds, an undulating movement from east to west, unaccompanied by noise. The clock in the tower almost stopped, but recovered itself. It faces south-southeast.

Oakland: the shock appears to have been very much more severe than at the Lick Observatory. The magnified record at the Chabot Observatory shows irregular vibrations distributed in all azimuths over a circle about 8 millimeters in diameter, with irregular loops running out about 18 millimeters from the center. These may be due to swinging of the pendulum. Time, 4.45.30. Duration, twenty seconds. The pier of the 8-inch equatorial telescope was cracked near the top, where it was 40 by 15 inches in cross-section, and the south side was shifted one-sixteenth inch toward the east, the north side remaining in position. The pier is of brick. The ferry clock at the foot of Market Street, San Francisco, stopped at 4.47.20. (Error \pm 3 seconds). The clock in the ferry-house at Oakland pier stopped 4.46.30; error unknown.—C. Burckhalter. (VI.)

Oakland: the first shock seemed to be from northeast to southwest, and was attended by three distinct, loud, sharp reports, followed by a rattling noise which gradually died away. No vibration of pendant objects, but rattling of windows for a longer time than I had ever before noticed.—J. B. Trembley.

East Oakland: at Mr. Blinn's observatory the record showed an indistinguishable mass of lines about 4 millimeters in diameter, with many loops roughly distributed over a circle about 18 millimeters in diameter, and finally a number of great loops extending as much as 35 millimeters from the center. The last are certainly due to swinging of the pendulum. They extended mostly in an east and west direction. Fully (VI).—F. G. B. Time about 4.47. A fresh plate was substituted immediately after the heavy shock, but the two subsequent lighter shocks made no record, and I did not feel them. They are described as being vertical and momentary.—F. G. Blinn. The first shock awakened me at 4.46.34, which must have been very nearly the time of beginning of the earthquake. Time of ending noted by Mr. A. S. Ireland at 4.46.45. The second shock occurred at 4.54.59, and was

quite slight, lasting only about three seconds. The correction of my watch was determined by transit observations by Mr. Blinn, shortly after the shocks occurred.—Wm. Ireland.

Berkeley: at the University observatory a diagram was obtained showing the effect of both shocks. The greatest oscillations are in an east and west direction. (About 13 millimeters, magnified, but the pen did not return to the starting point, stopping about midway on the diagram. The greatest motion is perhaps 6 millimeters.) Time 4.47 a. m. "It seemed to me the sharpest shock since 1868. It was followed by three slight tremors, and another at 6.20 p. m."—Prof. Soulé.

San Francisco: time 4.46.38.—Prof. Davidson. 4h. 46m. a. m. Shock in 3 distinct waves; the first lasting 5s., N. E. and S. W. for the middle wave, followed by light waves. Total duration 30 seconds.—T. T.

Carson City, Nevada.—The earthquake of July 31 was not felt here. The seismograph did not show a trace.—C. W. Friend.

Reports sent to the San Francisco papers follow, all dated July 31: San José: there was a heavy shock at 4.45 this morning, the heaviest in seven years. No damage was done, and there was no excitement. The oscillations appeared to be north and south.

Oakland: the earthquake was quite severely felt in Oakland. The shock was very sharp, but little damage was done.

At the students' observatory at Berkeley the shock was registered as occurring at 4.47 o'clock in the morning and lasting fifteen seconds. The vibration was from north of west to south of east. It was followed by three slight ones at short intervals. Prof. Soulé says that this was the most severe earthquake that he has experienced since he came to California, in 1869.

Sacramento: there was no earthquake here.

Napa: an earthquake at 4.45 this morning, preceded by tremors which continued about six seconds. The shock which followed was quite heavy, lasting four seconds. The vibrations were north and south. No damage.

Petaluma: two heavy shocks at 4.45 o'clock a. m. The vibrations were from east to west.

Martinez: there was a severe shock at 4.50 o'clock this morning, lasting several seconds. No damage.

Gilroy: there was a slight shock at 5 o'clock this morning.

Santa Cruz: an earthquake was felt here at 4.50 o'clock this morning, lasting several seconds. The vibrations were west to east.

Centerville: two heavy shocks at 4.47 o'clock of about twenty-five seconds' duration. The vibrations were east and west. No damage has been reported as yet.

Los Gatos: a severe earthquake at 4.50 o'clock. The wave was east to west. Houses creaked, glass rattled, and many were awakened out of a sound sleep (VI). Considerable alarm was felt.

Santa Rosa: a sharp earthquake at 5 o'clock this morning, lasting about five seconds. The vibrations were southeast to northwest.

Benicia: three distinct shocks at 4.50 o'clock this morning. The first was quite strong and lasted several seconds, and was followed by two lighter ones. The vibrations seemed to be north and south.

Newark: a severe shock at 4.45 o'clock. The vibrations were from north to south and the duration was about ten seconds.

Concord: at 4.40 o'clock this morning a sharp shock, succeeded by a tremble that lasted fully two minutes. The direction of the shock was southeast to northwest; duration, thirty seconds. At about 3 a. m. a light shock was felt. In the night also another.

San Leandro: the heaviest shock since 1868 occurred at 4.46 o'clock this morning. A low rumbling sound preceded the first and heaviest shock, which lasted about one and a quarter minutes. The first half minute the oscillations were light and easy. Then for a quarter of a minute they were heavy, after which they gradually became less and less. Ten minutes after the first shock another slight shock was felt, and six minutes later another. The oscillations were from north to south. The damage includes one chimney thrown down and some crockery broken (VII).

1889. 6:19:39 p. m.

Oakland: slight shock (I) momentary.—F. G. Blinn.

1889. August 7; 3:43; 11 p. m.

Mount Hamilton: very slight shock suspected by E. S. H. (I?).

1889. August 13; 4:43 a. m.

Oakland: sufficient to awaken a few sleepers (III, IV?). Appears to have been very local in character, and confined to Alameda and Central and West Oakland, as it was not felt in San Francisco or East Oakland. "Slight."—Cal. S. W. Service Review.

1889. August 23; 2:32:46 p. m.

Mount Hamilton: very slight shock. Felt by some persons and not by others in the same room; time, 2.32.46.—E. S. H. Time, 2.32.48.—J. M. S. Ewing machine not started. Very small record on the duplex pendulum seismograph (I).

1889. August 27; 6:15 p. m.

Southern California: not felt at Mount Hamilton. The following are dispatches to the San Francisco papers:

Pomona: this evening at 6.15 the most severe shock that has been felt in this locality for fifteen years was observed. There were two distinct shocks, accompanied by a peculiar noise that sounded as though houses and buildings were falling. The shocks were about a second apart. Several people were thrown to the floor and nearly every one ran out of doors in a moment. Dishes were rattled from shelves, and in the stores goods were thrown down on the floor. Many windows were cracked and broken and buildings shook, but no damage was done to them. At the Pomona Progress office the type was pied, and at the Hotel Palomares glassware and crockery were broken (VII).

Los Angeles: a sharp shock occurred here at 6.13 this evening. It began with a light tremor, which lasted a few seconds. Then the vibrations grew stronger and ended with two heavy shakes. The entire duration of the disturbance was about ten seconds. Clocks stopped and ceilings cracked. Many people ran into the streets. So far as now known no damage was done, but the quake was the most severe experienced here in many years (VII).

Santa Ana: two very marked shocks occurred here this afternoon at 6.12. The vibrations were from southwest to northeast and followed each other in quick succession. Crockery rattled, chandeliers and swinging signs vibrated, and people in the second and third stories of buildings were considerably frightened in some cases. The quaking continued for seven seconds, but no damage whatever resulted (VII).

Santa Monica: there was an earthquake here at 6.16 p. m., lasting eight seconds. It was very noticeable in all buildings, but not strong enough to do any damage. The vibrations were from north to south. It was the first known here for many years.

Pasadena: a very perceptible shock at 6.20 p. m., lasting from five to six seconds. Dishes on the dinner-tables were shaken and some were broken (VII).

San Bernardino: "quite a distinct shock of earthquake was felt in this city last evening at about 6.15. The vibrations lasted several seconds and were from east to west."—*San Bernardino Times-Index*, August 28. A light shock (III). Time noted by George Jordan, jeweler, at 2.12.20 p. m. Clock one minute fifteen seconds slow by Signal Office signals, hence Pacific standard time = 6.13.35. A slight rumbling noise before the shock is generally reported. The shock is described as a single impulse, lasting but one or two seconds, but reports disagree as to direction of the vibration.—W. C. Parmley.

1889. "In the autumn," 18h.

An earthquake at Puyallup, Washington. Intensity II. Several shocks.—P.

1889. September 24; 8 a. m.

Reported in S. F. papers:

Napa: there was a slight earthquake at 8 o'clock this morning.

Winters: there was a slight shock here this morning just before 9 o'clock. The direction of the shock was from west to east.

Woodland: quite a heavy earthquake at 8 o'clock this morning. There were two distinct vibrations and they were from north to south.

1889. September 29; 8:10 p. m.

Wawona: there were heavy shocks of earthquake at 8.10 Sunday night and at Yosemite followed by two lighter ones. The vibrations were east and west and lasting twenty-two seconds. Other light shocks were reported at Yosemite. A special dispatch from J. H. Lawrence, at the Big Tree Grove, says there was a severe shock of earthquake at 9.30 Sunday evening, continuing about twenty seconds. The vibration was distinctly east and west, accompanied by a rumbling noise resembling a heavy train of cars crossing a bridge, followed by two lighter shocks. Hollow logs and trees oscillated (VI or more severe).

1889. September 29.

Rancho Laguna de Tache, Kingsburg: a slight shock in section 29, T. 17 S., R. 21 E., at 9.20 p. m.—S. C. Lillis. (See preceding paragraph.)

1889. September 30; 12:17:30 p. m.

Kingsburg, same place as above. A slight shock.—S. C. Lillis.

1889. October 15; 4:30 a. m.

Carson: E. W., light.—C. W. F.

1889. October 20; 3 p. m.

Point No Point Lighthouse, Washington. Slight shock.

1889. October 24; 7:20 a. m.

East Oakland: tracing obtained with seismograph shows (magnified) vibrations of about 1.6 millimeters. The pen did not return to the starting point. Light shock (II) noticed by several persons. Time noted by Mr. Ireland at 7.19.45 (wrongly given in the Oakland papers as 7.15). Felt by one or two persons in Oakland and Alameda.—F. G. Blinn.

1889. November 14; 6:54 p. m.

San Lorenzo: the telegraph operator reports an earthquake at above time. East Oakland: the seismograph record shows a (magnified) motion of 1 millimeter. The shock was not felt here by anybody.—F. G. Blinn.

1889. November 15; 7:55 p. m.

East Oakland: a slight shock (II) felt by three persons in the vicinity. No record on seismograph, hence motion was probably vertical. The shock was felt in San Francisco, and noticed in the daily papers.—F. G. Blinn.

San Francisco, 7h. 55m. p. m. Light shock. Duration 2 seconds.
—T. T.

Healdsburg: "a very severe shock of earthquake was felt in this city last night at 7.55. It was the heaviest experienced here in many years."—S. F. papers.

1889. December 2; 6:30 p. m.

East Oakland: the seismograph record (magnified) shows a number of nearly circular tracings about two millimeters in diameter, inclosing short irregular lines in different azimuths. The time was noted by a neighbor, as I was not at home when the shock occurred.—F. G. Blinn.

1889. December 14; 5:30 a. m.

Carson: E. W., light.—C. W. F.

Note by Dr. Keeler.—"The present bulletin is to be regarded as little more than a list of recorded earthquakes in California in 1889 and a collection of such data as are available for estimating the intensities of the different shocks. Accurate observations of earthquakes are difficult to obtain, as the instruments employed require some skill in the observer and a certain amount of attention to be always in working condition. The sensations experienced during an earthquake shock vary greatly for different persons, and descriptions based on the feelings alone are apt to be extremely unreliable. It is hoped, however, that other stations provided with suitable instruments can be established in different parts of the State, and that eventually sufficient data can be accumulated for a more complete study of earthquake phenomena on the Pacific coast than the material now available would permit." *These remarks apply to the whole of the present volume.*—E. S. H.

EARTHQUAKES ON THE PACIFIC COAST, 1890.

1890. January 15; Mount Hamilton; 5:05 \pm 1m. a. m. (Prof. Holden).

Intensity = V.—Mr. Keeler noted the time by watch, P. S. T.¹ = 5.05.3 \pm 10s. a. m. Intensity = IV. Time by earthquake clock = 5.02 a. m.

The record of the duplex seismograph shows the actual displacement of the pendulum bob to have been 2.6 mm., in a direction

¹ P. S. T.—Pacific slope time, which is Greenwich time *less* 8 hours.

almost exactly northwest and southeast. The record consists of a single nearly straight line.

San José: two shocks felt about 5 o'clock a. m., sufficiently heavy to awaken sleepers; from north to south.

1890. January 18; Napa.

Two slight shocks. Vibrations from north to south.

1890. Santa Barbara; 3:30 p. m.

Reported in the *Chronicle* as "quite a heavy shock."

1890. January 23; Chabot Observatory; 4:18 \pm 1m. a. m.

Time observed by George B. Fox. The seismographic record indicates the total actual displacement of the pendulum to have been 2.8 mm., in a direction from "north by east" to "south by west." The tracing is made up of five small waves (small with reference to the total length of the tracing), which look as if they might have resulted from a simple harmonic motion having displacements in an east and west direction.

1890. January 23; 4 a. m.

Berkeley: slight shock.

1890. February 1; 5:15 p. m.

Admiralty Head Lighthouse, Washington: light shock.

1890. Santa Ana, January 24.

The San José *Mercury* reports:

A very distinct shock, lasting 4 seconds, was felt this afternoon at 1.15; and at 4.30 o'clock there was a larger and more pronounced shock, lasting ten seconds. The direction was northeast and southwest.

1890. February 5; San Diego; 10:15 p. m.

"Distinct shock; vibrations from east to west."

1890. Santa Ana; 10:14 p. m.

"Shock lasted eight seconds. Vibrations from northeast to southwest."

1890. February 5; San Bernardino.

"Three distinct shocks, preceded by a low rumbling noise. The shock (?) lasted for four or five seconds."

The three reports above are all from newspapers.

1890. February 9; San Bernardino; 4h. 6m. a. m.

Following is the report published in the *Times-Index* of San Bernardino of February 10:

"Quite a heavy shock yesterday morning at 6 minutes past 4 o'clock. The vibrations were north and south."

The *Examiner* of S. F. reports the following:

1890. San Pedro, February 9; 4h. 7m. a. m.

Three mild but distinct shocks. The vibrations lasted for several seconds and were from east to west.

1890. Colton, February 9.

A heavy shock at 4 o'clock this morning.

1890. Pomona, February 9.

At 4 o'clock this morning three distinct shocks were felt here.

Nearly every one was roused from his slumbers, but little damage was done. In the *Progress* office type was "pied," and some panes of glass were broken about the city (VI).

1890. San Diego, February 9.

An earthquake was felt at 4 o'clock this morning. It lasted about a minute, and was accompanied by rumbling noises.

1890. Tehachapi, February 13; 2:10 a. m.

The following is from the San Bernardino *Times-Index*:

Three light but distinct shocks. They occurred at intervals of about twenty minutes. The second shock lasted several seconds.

1890. February 15; Los Angeles; about 4 a. m.

Reported as follows in the Los Angeles *Herald* of February 16:

"Residents in this city and dwellers in its suburbs generally were very rudely awakened from their slumbers yesterday morning at about 4 o'clock (VI). A long, low rumbling noise as of distant thunder along the crests of the mountains was heard by people who were awake at that hour, and this was soon followed by a very decided shock. Houses shook, windows rattled, pictures vibrated on their hooks, and it was only very sound sleepers who were not roused. The oscillations were of a long, steady character rather than of the short, jerky order often felt in earthquake movements. The vibrations were nearly from northeast to southwest, and were separated into three distinct divisions. The first was the heaviest, followed by another lighter one at a short interval, and then, after a pause, a third little kick, less pronounced than the others. This is the second shock in this section within a year. In old days it was noted for its frequent seismic manifestations, but for forty years they have not been pronounced. Their center is near the San Jacinto peak."

Gilroy, midnight: a light shock.

1890. March 8;

Olympia, Washington, III.—P.

1890. March 15; 20h.

Roslyn, Washington, III.—P.

1890. March 29; 14h. 30m.

Roslyn, Washington, III.—P.

1890. April 11; Ukinah; 11:30 a. m. (?)

Vibrations from southeast to northwest.

1890. April 15; Mount Hamilton; 2:00 a. m.

No record except the tracing of the duplex seismograph, which is an almost perfectly straight line running northwest and southeast. The total actual displacement of the pendulum bob is 1.9 mm.

1890. April 24; Mount Hamilton; 3:36 a. m.

The duplex seismograph gives an exceedingly complicated tracing in the general direction northwest and southeast. The maximum possible displacement of the pendulum bob was 4.0 mm. in the direction indicated above.

At right angles to this the maximum displacement was 1.4 mm. The tracing is folded on itself from nine to eleven times.

1890. Mills College; about 3:39 a. m.

The tracing from the duplex seismograph indicates motion in every possible azimuth. There is no marked tendency in any one direction. The maximum excursion of the pendulum bob is 11.1 mm. running from north-northeast to south-southwest. By maximum excursion is here meant the maximum diameter of the diagram.

1890. Berkeley; 3:38 a. m. (Prof. Soulé).

The tracing from duplex seismograph gives maximum displacement (6.4 mm.) in a direction east-northeast and west-southwest. There is quite a well-marked displacement of 4.3 mm. in an azimuth which may be defined as "west-northwest" to "east-southeast." The tracing recrosses itself from fifteen to twenty times. The disturbance at Berkeley seems to have been considerably smaller than at Mills College.

1890. Chabot Observatory; 3:37:44 a. m.

Duration six seconds; preceded by a rumble lasting ten to fifteen seconds. General character and size of tracing from duplex seismograph about the same as that observed at Berkeley. Maximum double amplitude of pendulum bob nearly east and west, amounting to 5.7 mm. (Mr. Burckhalter.)

1890. East Oakland; 3:37:40 a. m.

Mr. F. G. Blinn reports the duration at ten seconds and the intensity as (IV). The seismograph tracing is exceedingly complicated, recrossing itself probably fifty times. The maximum displacement is east and west.

1890. San Francisco; 3h. 40m. a. m.

Sharp shock. Duration 16 seconds.—T. T. Following is the report of Prof. Davidson, as given by the *Examiner*: "(1) First shock light, but awakened observer at 3.36.18.—P. S. T. Direction, east and west. (2) Continuous shock 3.37.03 to 3.37.23; first part slight; last 'shock like a terrier-dog worrying a rat.' Trace east and west and north and south, giving resultant northeast and southwest or northwest and southeast, according to circumstances. Shock rang door-bell in Prof. Davidson's room. Stopped clock in room 39, Appraisers' Building. Recorded by Frank Edmonds as northwest and southeast" (VI).

The following from the *Evening Bulletin* gives observations in other parts of the State:

1890. Salinas, April 24.

The heaviest tremor ever known here occurred at 3.40 this morning. Two light shocks were followed by a third and heavier, which lasted about twelve seconds. These were followed by four or five more, one of which was sharp and abrupt. The vibration was from east to west. Clocks were stopped, but no damage was done (VI).

1890. Benicia, April 24.

The people were awakened from slumber this morning at 3.45 by a very distinct shock. The vibrations lasted some seconds and seemed to be from east to west (VI).

1890. Los Gatos, April 24.

Two distinct and severe shocks were felt this morning about 3.40, the last shock being much heavier than the first, and of longer duration. The vibrations were from east to west. No damage was done, but many persons were considerably frightened and a few clocks were stopped (VI). A slight shock was also felt about 5.30, but it was scarcely noticeable.

1890. Brentwood, April 24.

A slight shock at 3.30 this morning.

1890. Gilroy, April 24.

The damage by the earthquake this morning was not great. The gas mains were disjointed and the lights extinguished (VII?).

1890. San Jose, April 24.

The shock this morning was very sharp, but no damage is reported. Many people were frightened out of their beds (VI?).

1890. Hollister, April 24.

Tremors began here at 3.32 a. m., lasting until 5.30 a. m. Thirteen distinct shocks were felt, and during the entire two hours a con-

tinuous vacillating motion was observable. The shocks were not sharp, but long continued and heavy rolling, the worst that have ever been experienced here. Only nominal damage was done. A private despatch states that the McMahan House was twisted so badly that cracks were opened in it sufficiently large to admit a man's hand and that other damage was done (VII?).

1890. Redwood City, April 24.

Three shocks of earthquake occurred this morning, ending with a severe jar, which threw crockery and other articles from the shelves of several residences. Clocks were stopped at 3.37, the hour of the occurrence. The vibrations were east and west and the duration twenty seconds. The residents assert these were the severest shocks since 1868 (VI?, VII?).

1890. Point Reyes, April 24.

* A sharp shock of earthquake occurred here very early this morning.

1890. Centerville, April 24.

A heavy earthquake shock was felt here at 3.40 this morning. It was preceded by two light shocks. Many were frightened, but no damage has been reported.

1890. Watsonville, April 24.

There were twelve distinct shocks of earthquake felt here after 3.30 this morning, the first and second being the most severe. The vibrations were from west to east. In the country north of town nearly all the chimneys were thrown down (VIII). The railway bridge across the Pajaro was misplaced and the train delayed.

1890. Napa, April 24.

At 3.40 o'clock this morning a heavy shock of earthquake was experienced here. The vibrations were north and south.

1890. Santa Cruz, April 24.

There was a heavy earthquake shock this morning at 3.48, but very little damage.

1890. Mayfield, Cal., April 24.

A slight shock of earthquake was felt here and in neighboring towns this morning. The vibrations were from northeast to southwest, and lasted eight seconds. There was a heavy atmosphere, with no wind. The tops of trees rocked, making a noise like a heavy wind blowing. Plastering was broken and the depot clock and others stopped at 3.37 o'clock (VI). The temperature was 48°. Superintendent Bassett went south by a special train to look after the damage done to the track by the shake between Pajaro and Sargent's. It is reported that the track was moved a foot out of line, and that the ground settled six

inches in places. The bridge, fifty feet high, is impassable at both ends, the rails being pulled a foot apart. A large force of men is at work, and they expect to have the track so that trains can pass in a few hours. At Sargent and Gilroy there were more than a dozen shakes, and chimneys were knocked down. (VIII?) (See Gilroy preceding).

1890. Carson City, Nevada.

No time reported. The duplex seismograph indicates a disturbance about one-quarter as large as that at Berkeley. (C. W. Friend.)

1892. San José, April 24; 3:37:43 a. m.

Seismograph at the University of the Pacific furnishes a diagram having a maximum double amplitude of 16.2 mm. From the manner in which the index has run all over the glass one would think the equilibrium of the pendulum too nearly neutral.

1890. May 11; East Oakland; 1:00:15 p. m. (Mr. Ireland); 1:00:18 p. m. (Mr. Boise).

Mr. Blinn's seismograph makes the disturbance almost entirely in an east and west direction; its amount (maximum double amplitude) was 1.0 mm. The diagram which Prof. Keep sends from Mills College indicates a slightly smaller disturbance in a direction southwest and northeast.

1890. May 11; San Francisco; 1:00:15 p. m. (Mr. William Ireland).

Intensity = IV, Rossi-Forel scale. S. F.: 1h. 1m. p. m. Light shock, duration 2 sec.—T. T.

Following is a newspaper account of the shock as felt at San Leandro, May 11: "A very heavy shock of earthquake was felt at this place at 1.03 o'clock this afternoon. The oscillations were north and south and the duration 5 or 6 seconds. No damage reported, although many of the older houses in town were loosened up considerably, notably the depot of the Southern Pacific Company."

1890. May 14; Santa Cruz.

The following general account is taken from the newspaper of even date:

Ever since the big earthquake of the 24th of April there have been daily seismic disturbances along the line between Pajaro and San Juan, where the earthquake was heaviest. Each day three or four small shocks occur, and yesterday six quite pronounced ones were felt. Two were felt at 5 o'clock this morning in this city. The fissure made on the Chittenden ranch, above Pajaro, during the big earthquake has been gradually increasing in depth and width. The railroad company is keeping a force of carpenters in the vicinity of the bridges between Pajaro and Gilroy for fear of damage by the shocks if they get heavier.

1890. June 1; Healdsburg; 1:21 p. m.

Slight shock.

1890. June 12; 4 a. m.

Berkeley: slight shock N. W. to S. E.—Professor Soulé.

1890. June 29; Santa Rosa; 7:25 a. m.

"Three distinct shocks; people awakened; vibrations from north to south" (VI).

1890. Petaluma, June 30.

An earthquake about 6 o'clock a. m. The vibrations were from east to west.

1890. Santa Rosa, June 30.

Three earthquake shocks were felt here about 11 o'clock (a. m.?). They were not quite as severe as those in the morning.

1890. Santa Cruz, June 30.

Earthquake shocks in this city at 12:30 this afternoon shook all the houses in town. The first was slight and was followed in a second by a much heavier shake. No damage. The vibrations were east and west. A telegram from Sargent station, near the center of the seismic disturbance of last April, states that the shock was quite severe there, breaking crockery in the houses. (VI).

1890. June 30.

Berkeley: slight record on duplex instrument.—Professor Soulé.

1890. July 1.

San Francisco: "At 33 minutes past midnight of Monday there was a sharp shock of earthquake felt in this city, lasting ten seconds. The direction of the vibrations was principally northwest and southeast, with a shock nearly north and south. It was felt in nearly all portions of the city and had the effect of rousing many people from their slumbers. Gas fixtures and windows were set rattling, and in some houses picture frames, loosely fastened on the walls, were thrown to the floors. It was not noticeable by people walking on the streets, and had no distinct violence in the down-town hotels" (VI).

1890. July 1; Gilroy; 12:35 a. m. (newspaper).

"Sharp shock from north to south lasting about one minute."

1890. July 4; Eureka; 4:30 p. m. (newspaper).

"Quite a sharp shock."

1890. July 24; Bakersfield; 3 a. m. (newspaper).

"Severe shock."

1890. July 26.

The *Examiner* contains the following:

Sissons: There were three earthquake shocks this morning at 1.45 o'clock. The vibrations were north and south.

1890. Hydesville, July 26.

Several severe shocks of an earthquake were felt at this place at 1.40 a. m. to-day, lasting about twenty seconds, and another slight shock at 8 o'clock.

1890. July 28; Petaluma; 12:03:35 a. m.

Two slight shocks from north to south.

1890. August 17; Mills College; 6:50 a. m. (Prof. Keep).

Slight, but distinct shock. The tracing of the seismograph shows three vibrations *(averaging 0.3 mm.), in a direction from one point south of east to one point north of west.

1890. August 23; Mono Lake.

The following is from the *Homer Index*:

"Remarkable earthquake at Mono.—The southern end of Mono Lake was considerably agitated last Sunday, and dwellers in that shaky locality were much perturbed. Steam was issuing from the lake as far as could be seen, in sudden puffs, and the water was boiling fiercely, while high waves rolled upon the beach and receding left the sand smoking. In a moment the air was thick with blinding hot sulphurous vapor, and subterraneous moans and rumblings made the witness think that the devil was holding high carnival down below. The fences wabbled up and down and sideways.

"This appalling fracas lasted about two minutes. Then came a blessed quiet for a moment, followed by a sudden twitch of the earth, as a horse jerks his hide and dislodges a bothersome fly. The shock threw men and animals off their feet with bruising violence.

"It was some hours before the lake ceased to emit columns of steam and the water became very hot. Two springs near the house, long noted for the coldness and purity of their water, changed their character and spouted hot mud for two days, when they flowed cold water again. A stack of 200 tons of hay was moved 70 feet south without disarranging it" (IX?).

1890. September 3; Mount Hamilton; 2:21:20 p. m. (accurate to one or two seconds), P. S. T.

Felt by Prof. Holden in third story of brick house and estimated by him as II on Rossi-Forel scale. Recorded on duplex seismometer, but did not start the larger one.

A slight shock was also felt at San Francisco at 2.30 p. m.; likewise at Gilroy.

1890. September 4; Mount Hamilton; 10:06:45 a. m. (E. C. Holden).
"Swung the hanging lamp in my study."—E. S. Holden.

1890. September 5; Merced; 2:15 p. m.
Vibration east and west.

1890. Calico, September 19.

A severe shock of earthquake occurred at 12.15 last night. There were vibrations east and west. There was another shock fifteen minutes later.

1890. Daggett, September 19.

Two earthquakes were felt here at 12.25 and 12.50 this morning. The vibrations were east and west. No damage was done.

1890. San Bernardino, September 19.

A light earthquake shock visited this city a little after 12 o'clock this morning.

1890. Barstow, California, September 19.

There was an earthquake at 12.15 this morning, with a rumbling sound. No damage.

1890. October 3; Healdsburg; 12:05 p. m.

"Sharp shock, accompanied by long and distinct rumbling. Vibrations north and south."

1890. October 8; 2 p. m.

Point No Point Lighthouse, Washington, slight shock.

1890. October 29; Mount Hamilton.

Two distinct shocks.

First—8.36.29 a. m. \pm 2s., P. S. T. Rossi-Forel, IV to V.

Second—8.39.29 a. m. \pm 2s., P. S. T. Rossi-Forel, III. (Prof. Holden.)

Prof. Barnard reports as follows: "Coming to the observatory, half-way up the plank walk heard two distinct and heavy jars in the frame cottages as if they were falling down. These followed each other by about one or two seconds. *Did not feel any shock.* The noise of the shaking of the frame houses could have been heard perhaps an eighth of a mile. Reaching the observatory, another shock occurred; did not feel it; heard a rattling. This was at 8.39.35 \pm one or two seconds, P. S. T.

1890. December 4; Lone Pine; 9 o'clock p. m.

Ten distinct shocks felt from 9 to 11. No damage done.

"This is the first disturbance at Lone Pine for eight or ten years."—C. Mulholland.

EARTHQUAKES ON THE PACIFIC COAST, 1891.

1891. January 2.

Generally felt throughout the State.

1891. Lick Observatory (Mount Hamilton), January 2; 12h. 0m. 18s.

A violent earthquake shock stopped our standard clock at eighteen seconds after noon to-day. The pendulum swings about north and south.

Several ceilings were cracked in the observatory, and large pieces of plaster were thrown down in the brick houses. No damage was done to the instruments. The earthquake registers indicate by far the severest shock since 1868 in northern California. Its intensity was VII on the Rossi-Forel scale. The pen of the duplex seismometer was thrown completely off the glass plate. Some definite idea of the force may be had when I say that a swinging lamp, making a pendulum of about 15 inches in length, which is suspended in my study, was still in vibration twenty minutes after the shock.

Framed photographs on my mantel were overthrown. The large telescope is secured to its base by four holding-down bolts, and it is as safe as it can be made. (Professor Holden.)

San Francisco was visited by two distinct shocks of earthquake at noon yesterday (Jan. 2).

Prof. Davidson states that his chronograph recorded the time of the shock to be 12.00.40,¹ with an entire duration of fifty seconds. A comparison of directions observed by various persons indicates the wave to have moved from southeast to northwest. Long, rolling shock, duration 33 sec.—T. T.

1891. Santa Cruz, January 2.

There was a heavy earthquake here at 12.02 this afternoon. The shock, which passed from southwest to northeast, lasted ten seconds, and was the heaviest felt here in years. Only very slight damage was done, but the people were greatly frightened (VII).

1891. Salinas, January 2.

A very severe shock at 12 o'clock noon to-day. The vibrations were from north to south.

1891. El Verano, January 2.

A severe shock at 12.20 o'clock. It moved from southeast to northwest. Houses were shaken up.

1891. Los Gatos, January 2.

A sharp shock was preceded by a rumbling sound at 12.01 o'clock this afternoon. The duration of the shock was fifteen seconds.

¹ 22s. later than at Mount Hamilton.

No damage.—Berkeley: duration 3 sec. N. W. and S. E.—Professor Soulé.

1891. Gilroy, January 2.

One of the heaviest earthquakes ever felt here occurred at 12.01 this afternoon. The duration was less than half a minute, but it was accompanied by heavy rumblings and a sickening, swaying sensation. Gas fixtures and movables swayed and clattered considerably (VII?).

1891. Stockton, January 2.

Rather a sharp shock precisely at 12 noon. The vibrations were south to north.

1891. Lathrop, January 2.

There was a severe shock at 12 o'clock. Houses squeaked, clocks stopped, lamp chimneys were broken, etc. No further damage was done. Apparently the direction of the shock was from east to west (VI).

1891. Modesto, January 2.

A sharp shock was felt here at noon to-day. The shock lasted fifteen seconds. The vibrations were north and south.

1891. San José, January 2.

At 12 o'clock a sharp shock was felt here, the movement being north and south, and it lasted about fifteen seconds. Clocks were stopped and buildings rocked, but no damage was reported (VI?, VII?).

1891. San José, January 2.

"Buildings were shaken so that their motion was plainly visible. Many clocks stopped at 10.00.30 p. m."¹—*San José Herald*.

1891. Petaluma, January 2.

This afternoon, a few minutes past 12, a sharp shock, with vibrations from east to west.

1891. San Leandro, January 2.

A sharp shock was felt here to-day at 12.02. The oscillations were from northeast to southwest. The duration was about ten seconds.

1891. San Rafael, January 2.

A rather sharp shock was felt here at 12 noon to-day, lasting several seconds. The vibrations were from east to west.

¹ 12s. later than that at Mount Hamilton.

1891. Boulder Creek, January 2.

A severe shock was felt here at 12 o'clock, continuing for several seconds. The vibration was from southwest to northeast. There was a general rush for the streets, but no damage was done (VII).

1891. Spanishtown, January 2.

A severe shock occurred at three minutes before noon to-day. The vibrations were from east to west.

1891. Merced, January 2.

A slight shock was felt here at 12 o'clock to-day with vibrations from east to west. The shake was heavy enough to cause the glassware on the shelves to rattle (VI?).

1891. Redwood City, January 2.

Two sharp shocks were felt here to-day at two minutes past noon. The vibrations were east and west.—*S. F. Examiner.*

Seismographic records obtained at Mills College by Prof. Keep and at Oakland by Mr. Blinn show the greatest disturbance to be in a direction running from northeast to southwest.

Mr. Blinn's seismometer gives a diagram indicating that the maximum double amplitude of the pendulum was 3.8 mm. The diagram consists of many (not less than 25) intersecting loops. So far as one may judge from the tracing, the instrument was in good adjustment.

Prof. Keep's tracing is of the same general character, but with a maximum double amplitude of 5.8 mm.

The Carson City seismometer (C. W. Friend) gives a tracing even more complicated than either of the preceding; it is the smallest of the three, but every azimuth is filled with fine lines. The glass plate of the San José instrument was jarred by the earthquake and the record spoiled.

A third shock of intensity (III) on Rossi-Forel scale is reported by Prof. Holden as occurring at the Lick Observatory at 8.18.21 p. m.

1891. January 12; Berkeley; 1:36 a. m.

Prof. Hilgard reports a "light earth-tremor lasting a little less than a second, but preceded by a marked rumbling from the southwest." (Qu.?, a. m.?)

1891. January 13; Mount Hamilton; 2:58 p. m.

I to II Rossi-Forel scale; observed by Mrs. Breseno.

1891. February 15; Downieville.

Quite a shock felt between 2 and 3 a. m.

1891. January 21; San Francisco; 2:24:35½ p. m.

Artificial earthquake, caused by the explosion of 3,000 pounds of blasting powder for the purpose of clearing away a hill in San

Francisco. But few rocks were scattered; the hill collapsed and the earth in the neighborhood showed deep crevices. No disturbance was observed on the San José seismograph, which was watched by Prof. George. Nor was any record obtained at Mount Hamilton, where it was looked for with mercury basins.¹

1891. February 24; Independence; 3:10 a. m.

Reported by Mr. C. Mulholland as follows: "A strong earthquake shock. The tremor was preceded an instant by a rumbling sound. The motion appeared to be a little east of south to west of north. The house shook so that the pans and dishes rattled. A strong breeze from the south had been blowing all night, but at the time of the tremor there was a brief but complete lull; then the breeze set in as before."

1891. March 7; 7:35 p. m.

Admiralty Head L. H., Washington. A light shock.

1891. March 7; 7:30 p. m.

Smith Island L. H., Washington. A slight shock.—Ms. U. S. L. H. Board.

1891. April 4; Mount Hamilton; 4:30 a. m.

"A light, but prolonged shock from east to west," reported by Prof. Holden.

1891. April 12; Mount Hamilton; 9:29(?)41.

"A sudden, slight earthquake of intensity II, Rossi-Forel scale," reported by Prof. Holden.

1891. April 13; Healdsburg.

A sharp shock at 11.40 p. m.

Visalia: earthquake at 10.30 p. m. Vibrations from north to south.

1891. San Francisco, May 6; Sh. 30m. p. m.

Light shock, duration 4 sec.—T. T.

1891. Berkeley, May 8; 6:10 p. m.

Prof. Soulé writes: "Very slight in San Francisco and Oakland, so much so that comparatively few people noticed it. The Ewing and Gray-Milne instruments, though in excellent order and very sensitive, were not set off. The duplex gave a small record indicating that the direction of the shock was from northwest to southeast. I should rate it as II in the Rossi-Forel scale."

1891. San Rafael, May 8; 6:08 p. m.

A heavy shock lasting about six seconds. The vibrations were from west to east.

¹ *Publications Astronomical Society of the Pacific*, vol. III, page 132.

1891. May 19; Susanville.

Seven shocks felt; two very heavy; time not reported.

1891. May 20; San Francisco; 10h. 4m. p. m.

Light vibration, duration 2s.—T. T. Mills College: Prof. Keep writes: "An earthquake was felt here last night about 10 o'clock. The shock was slight, but was preceded by a peculiar sound which made me brace myself for a severe shock." The seismographic record accompanying this letter shows the greatest disturbance to have been in a north and south direction.

1891. June 22; Pasadena and San Fernando.

Slight shocks felt between 8 and 9 o'clock in the evening.

1891. June 28; San Francisco; 3:02:45 a. m.

Reported in S. F. *Chronicle* as follows: "A double shock of earthquake occurred early yesterday morning. It was not heavy, and was of such brief duration that not many of the citizens who were awake at the time could have noted it. F. W. Edmonds, the assistant in Prof. Davidson's observatory, was at work when the shock came and noted its features, afterwards comparing his figures with those recorded by a small seismograph. The first shock began at 3.02.45, Pacific standard time, and ended five seconds later. The vibrations were east and west. Then at 3.03.05 there was another shock, so brief that the duration was not recorded. It was sharper than the first shake, but had the same motion.

Prof. Davidson remarked that one night last week, while he was making observations for latitude, there was an almost imperceptible quake. He was reading the level of the instrument at the time and noticed that it was suddenly shaken, the bubble moving backward and forward several times in quick succession. The extremes of this motion as marked by the bubble were three or four millimeters apart. The vibrations were north and south."

Mount Hamilton: waked sleepers, set hanging lamps in vibration, rattled windows, pictures, stoves, etc. Ewing seismograph clock did not start; components were therefore recorded as straight lines. The actual displacements of the earth [magnified] were as follows: North and south = 0.24 inches; east and west = 0.39 inches; vertical = 0.15 inches.

Mr. Campbell makes the time 3.02.36 \pm 2s.—P. S. T.

Mr. Schaeberle makes the time 3.02.35 (watch).—P. S. T.

Intensity on Rossi-Forel scale, V.

1891. Santa Cruz; June 28; about 3 a. m.

Shock not felt at the lighthouse, two miles from town. (Ms. kindly communicated by U. S. Geological Survey.)

Mayfield: "a slight shock of earthquake was felt here at 3 o'clock this morning. It lasted four seconds. Trembling vibrations were followed by two shocks."—*S. F. Chronicle*.

1891. June 29; Mount Hamilton; 8:06:31 ± 2 a. m. (W. W. Campbell); 8:06:32 (J. M. Schaeberle).

One quick shock lasting for less than half a second; Rossi-Forel I or II. "Recorded on duplex, but not on Ewing seismometer."

1891. July 12; Berkeley.

Slight record on duplex instrument.—Professor Soulé.

1891. July 13; Monterey; 4:27 p. m.

A sharp shock with vibrations from southwest to northeast. Clocks were stopped and crockery thrown from the shelves (VI).

1891. July 13; Santa Cruz Lighthouse; 4:26½ p. m.

Duration about two seconds. (Ms. of U. S. Geological Survey.)

1891. July 17; Hollister; 1 a. m.

Quite a severe shock; no damage.

1891. July 30.

Lerdo, Mex., was the center of a very severe earthquake about 6 o'clock a. m. It appears to have caused a tidal wave of considerable height at the head of the Gulf of California. The country is so thinly and poorly settled that no damage was done. The reports of this earthquake are so indefinite and contradictory that we have little reliable information regarding what must have been at least a very widespread disturbance.

1891. August 9; Monterey; 9:41 a. m.

A heavy shock, causing buildings to rock. The vibration was from north to south.

1891. August 9; 9:42 a. m.

Santa Cruz Lighthouse: duration 2 seconds. (Ms. of U. S. Geological Survey.)

1891. August 11; Humboldt Lighthouse.

Three shocks in rapid succession, (1) at 3h. 18m. 30s. a. m., (2) at 3h. 18m. 20s., (3) at 3h. 18m. 5s. (sic). N. B.—All the times at this station are from a clock which is regulated by the (calculated) times of sunrise and sunset. (Ms. kindly communicated by the U. S. Geological Survey.)

1891. September?

Tacoma, Washington, II, several shocks.—P.

1891. September 10; Berkeley.

Very distinct record, E. S. E. and W. N. W.—Professor Soulé.

1891. September 12; Cedar City, Utah; 8:48 p. m. (C. Mulholland).

"Shock heavy and accompanied by a sound like that of a heavily loaded wagon passing over a street paved with granite blocks. Its duration was brief, and there was but one shock."

1891. September 16; Salem, Oregon; 8:30 p. m.

The shock was brief and distinct, and was followed by a wave-like motion lasting several seconds. It was felt in all large buildings; windows rattled.

1891. September 21; Port Angeles, Wash.

Reports differ as to time, some claiming that the shock occurred at 4.10 a. m., others at 5 a. m. It is possible there were two distinct shocks. The direction of vibration was from northwest to southeast. Many people were awakened from sleep. Houses trembled and chinaware rattled (VI).

Port Townsend: shock felt shortly after 4 o'clock a. m. Dishes rattled and sleeping people were awakened (VI).

1891. September 22; Victoria, B. C.; 3:40 a. m.

Sharp shock felt all over city; lasted about seven seconds.

1891. September 23; Healdsburg; 1:30 p. m.

"Very severe and long-continued shock; one of the most severe ever felt in this vicinity."

1891. October 2; Mount Hamilton.

Prof. Barnard reports "from one and one-half to two seconds' duration. A very decided shock. Gradually increased in intensity. 7.19.55 P. S. T. end of shock." Prof. Holden gives the time as 7.19.55. Intensity II on Rossi-Forel scale. No record on seismometers.

1891. October 11.

Felt generally over the central portion of the State. Following are newspaper accounts:

San Francisco: a slight earthquake shock was felt throughout the city last night. It seemed like the heavy, noisy rumble of a cart, and was perceptibly felt in every part of the town. Prof. Davidson was at work in his observatory when it occurred. The pier upon which his instrument is placed was not thrown out of level in the slightest degree. The earthquake lasted for thirteen seconds, beginning at twenty-seven minutes and thirty-two seconds after ten o'clock and ending at twenty-seven minutes and forty-five seconds after 10 o'clock. An unusual feature of the shock was that it began light and gradually increased until it was greatest during the last three seconds. The direction was southeast to east-southeast.

1891. San Francisco, October 11; 10h. 28m. p. m.

Heavy shock, S. E. and N. W., duration 20s.—T. T.

1891. Suisun, October 11.

At 10.29 o'clock to-night a heavy shock of earthquake shook up this quiet little city in a frightful manner. The shock lasted nearly half a minute. It was the heaviest earthquake known of here for years. The damage is slight, but the fright of the people was extreme (VII).

1891. Oakland, October 11.

A sharp shock at 10.26, the vibrations being from north to south. Windows were shaken, but no damage done.

1891. Oakland, October 11.

Oakland: Mr. Burckhalter reports from the Chabot Observatory that the mean time clock was stopped at 10.27.49 p. m. His seismograph shows the actual displacement of the earth to have been 2.5 mm. in an east and west direction (VI).

1891. Sacramento, October 11.

A pretty lively shock of earthquake, or a double shock, was felt here at 10.28, but it was not heavy enough to do any damage. Many persons did not feel it.

1891. San José, October 11.

A slight shock of earthquake was felt here at 10.28 this evening. The movement was from northeast to southwest.

1891. Berkeley; 10:25 p. m.

Slight at first; gradually increased; preceded by a rumbling noise.—Professor Soulé.

1891. Winters, October 11.

There was a heavy shock here about 10.30 o'clock. It was heavy enough to wake people from a sound sleep. The vibrations were from east to west and lasted two or three seconds (VI).

1891. Fairfield, October 11.

There was a heavy shock at 10.30 p. m. and another at 4 a. m., but no serious damage was done.

1891. Spanishtown, October 11.

Quite a heavy shock was felt here at 9.29.

1891. Sonoma, October 11.

Sonoma and vicinity were visited at 10.28 o'clock by the severest earthquake ever felt in this section of the State. The people were shaken out of their beds, chimneys were demolished, windows broken, and the interior of almost every plastered house

in the town shows effects of the shock, which lasted about eight seconds. The tremor was a series of vicious twisters. Pickett's residence and wine cellar at the outskirts of the town were badly damaged, the interior of the house presenting a scene of desolation. On S. F. Ringstrom's farm a large chimney fell. Several chimneys in town were also overthrown, but fortunately no one has been injured. Reports from all over the valley show more or less damage. On the Polpula ranch, which contains a number of warm-water springs, the earthquake caused the water to gush forth in perfect torrents. The first shock of the evening was slight and felt at 9.15. Then came the heavy one, after which, at intervals of an hour or so, there were eight or ten other shocks. More or less damage was done to every building in Sonoma Valley (VIII).

1891. Petaluma, October 11.

At twenty-five minutes past 10 the heaviest earthquake shock since 1868 passed through Petaluma. Door-bells were rung and some plastering badly cracked. The heavy shock was preceded a few minutes by a light one, and after it came six or seven other shocks, the last one being at 5 o'clock this morning. Many people were kept awake most of the night. The main shock lasted fully nine seconds (VII).

1891. Napa, October 11.

The heaviest shock ever felt here was experienced at 10.34 o'clock. The people rushed out into the streets greatly frightened, and the whole town was in commotion. The shock was especially heavy at the insane asylum, and the inmates were almost uncontrollable.

The first shock came at 9.16, but it was light. At 10.29 came the heavy shock, which lasted forty-six seconds. It was a twisting motion from right to left. Some people fainted, and all were greatly exercised, but no fatalities are reported. Lighter shocks followed during the entire night. Some say there were twelve shakes, while others profess to have counted as high as seventeen. Some people remained in the street all night, and others did not sleep for fear of a repetition of the dread sensation. The damage will not be very heavy on any one building, but in the aggregate is considerable. Scores of chimneys are thrown down or turned three-fourths around. Many brick buildings are badly cracked, and the wall decorations in most of the fine houses are badly damaged, while nearly every house had some bric-a-brac and crockery destroyed. The insane asylum reports some damage to the walls and tower, but nothing serious (VIII).

1891. St. Helena, October 11.

The heaviest earthquake shock ever experienced here occurred at 10.30 o'clock. Houses shook, crockery rattled, and clocks stopped.

The vibrations appeared to be south to north, followed half an hour later by a light shock, and one also at 5 o'clock this morning (VI?, VII?).

1891. Santa Rosa, October 11.

The severest earthquake felt here in four years occurred at 10.32 o'clock. The oscillations lasted forty-five seconds. A slight trembling was perceptible for three or four minutes.

1891. San Rafael, October 11.

The most severe earthquake experienced here for years was felt at 10.26 o'clock. The shock lasted about twelve seconds. It was preceded by a dull rumbling noise like a heavy wagon rolling over the pavement. Two shocks of lesser power were felt this morning about 4 o'clock.

1891. October 13; Mount Hamilton; 11:0:30 p. m. (Prof. Holden).

Intensity II, Rossi-Forel scale.

Prof. Barnard reports as follows: "Three shocks of earthquake were felt in rapid succession. Interval between the individual shocks about one and a half seconds. The last of these three was the most severe. This occurred at 11.00.09 P. S. T. The shocks were simply quick jerks, and ought to have been powerful enough to wake a person from ordinary sleep."

1891. October 13; Mills College; 10:28 p. m.

Prof. Keep sends a very complicated diagram from his seismograph, indicating disturbances in all directions. Maximum north and south = 3.0 mm.; maximum east and west = 4.0 mm.

The above figures are for the actual displacements of the earth.

1891. October 14; San Francisco; 4:33:23 a. m.

Felt in all parts of the city. Prof. Davidson says: "The last shake was similar to the one of the 11th instant in its wave-like vibrations. Its greatest force was during the first seven seconds, and its entire duration was ten seconds. Time of beginning, 4.33.23 o'clock a. m. Direction of the vibration, north and south." Following are newspaper accounts:

1891. Napa, October 14.

The earth continues to tremble. Four shocks have been felt here this morning. At 4.30 a. m. the people were startled with quite a heavy shock, and several lighter ones have followed. The damage done by Sunday night's shock is much more than was at first supposed and will amount to several thousand dollars. Many of the people here are so terrorized that they have hardly slept since Sunday evening, and the slightest shock now starts many into the streets."

1891. Berkeley, October 14; 4:40 a. m.

Slight shock, N. and S.—Professor Soulé.

1891. Petaluma, October 14.

Another lively earthquake shock this morning about 4.30 o'clock, and a much lighter one about 7. The vibrations were north to south.

1891. Suisun, October 14.

Shortly after 4 o'clock this morning the people here were aroused from their slumbers by another sharp, severe shock of earthquake. It was not as severe as the first one that occurred on Sunday night (VI?).

1891. San Rafael, October 14.

Quite a severe shock was felt here this morning at 4.25 o'clock. The shock lasted about ten seconds. The vibrations were from west to east.

Prof. Keep reports that the seismograph at Mills College indicated an actual displacement of the earth in an east and west direction amounting to 1 mm.

1891. October 27; Mount Hamilton; 6:35:43 ± 1s. (Prof. Holden).

Intensity I or II on Rossi-Forel scale. Prof. Barnard reports this as "a decided shock," occurring at 6.35.44.

1891. November 8; Ashland, Oregon.

Following is the newspaper account: "The first time an earthquake has been felt in Ashland for years was last night about 8 o'clock, when a distinct shock, though light and lasting only a very few seconds, caused a general rattling of window panes in many buildings in town. The shock was not heavy enough to cause even timid people any alarm."

1891. November 29; Seattle.

At 3.21 o'clock this afternoon two shocks of earthquake, lasting about five seconds each, were felt here. No damage was done. The direction of the vibrations was southeast to northwest. One building swayed so much that the elevator bumped against the side of the shaft and could not move until the shock was over. Lake Washington, on the east side of town, was lashed into a foam, and the water rolled on to the beach 2 feet above the mark of the highest water and 8 feet above the present stage. Reports from Snohomish and Bellingham Bay towns say the shock was plainly felt there.

1891. Pysht, Washington, November 29; 3:34 p. m.

Duration about ten seconds. Panes of glass broken in the hotel (VI?). (Observer U. S. Weather Bureau, through U. S. Geological Survey.)

1891. Port Townsend, November 29.

A distinct shock of earthquake was felt here at 3.14 this afternoon. The shock continued fully twenty seconds. Buildings shook, windows rattled, and many persons rushed out of their houses. There was no damage done (VII).

1891. Tacoma, November 29.

A slight earthquake was felt all over the city at 3.16 this afternoon. No damage was done. A severe shock but no damage done at Olympia, 15h. 15m., II.—P.

1891. Mendocino, November 29.

Two shocks of earthquake were felt last night at 10.45 o'clock, preceded by a rumbling noise. There were two-minute intervals. Point Wilson Lighthouse, Washington, Nov. 29, 3 p. m. Admiralty Head L. H., Washington, 2.57 p. m. Point No Point Lighthouse, Washington, Nov. 29, 3 p. m., clocks stopped.

1891. December 16; Mount Hamilton; 8:28:12 a. m.

Prof. Schaeberle estimates the intensity at I on the Rossi-Forel scale.

1891. December 21; Mount Hamilton; 6:15:41 \pm p. m. (Prof. Holden).
Intensity II on Rossi-Forel scale.**1891. December 23; Berkeley [11 $\frac{1}{2}$ p. m.].**
Very distinct record.—Professor Soulé.**1891. December 29; Mount Hamilton; 3:26:56 \pm 3s. a. m.**
Intensity I to II on Rossi-Forel scale.

EARTHQUAKES ON THE PACIFIC COAST, 1892.

1892. January 16; Mount Hamilton; 7:30 a. m.

Note by Prof. Holden: "Wind from north and northwest. Velocity 61 miles per hour. The motion of the third story of Prof. Holden's house from the wind made a tremor which would have been called II on Rossi-Forel scale. No earthquake."

1892. January 22; Arcata (Cal.).

A shock.—Cal. S. W. Service *Bulletin*.

1892. January 30; Humboldt Lighthouse; 9 p. m.
(Ms. from U. S. Geological Survey.)**1892. February 1, Winchester (Cal.).**
A shock.—*Ibid.***1892. February 3; Portland, Oregon; 8:30 p. m.**

A severe earthquake shock occurred here at 8.30 o'clock to-night. Brick buildings swayed and windows rattled, terrifying the inmates, who in many instances rushed into the street. The shock

lasted about thirty seconds, and was probably the most severe earthquake ever felt in this city. As far as known no damage was done (VII).

1892. February 3; Astoria, Oregon; Sh. 27m. p. m.

The vibrations were from southwest to northeast. It lasted about three seconds, causing houses to shake perceptibly, but no damage was done.

1892. February 3; Salem, Oregon; Sh. 32m. p. m.

The vibrations were from northeast to southwest. There were three distinct shocks. Windows rattled and buildings trembled, but no damage is reported.

1892. February 3; Yaquina Head Lighthouse, Oregon.

A light shock about 8.20 p. m. Warrior Rock Lighthouse (Columbia River) a shock Feb. 3, 8.40 p. m., N. to S.

1892. February 5; Mount Hamilton.

Prof. Holden was awakened by a shock and noted the time as 6.27.42 a. m. Intensity = V to VI, Rossi-Forel scale.

Mr. Otto Erle was awake and dressing and noted time 6.27.50 a. m. Direction north and south. Prof. Campbell was awakened by the shock and noted the time as $6.27.50 \pm 3s$. Intensity, R. F. = V; duration, two seconds; north and south. Rattled windows, wash-bowls, etc.; rocked bed. Also felt at Niles.

1892. February 23; Carson City, Nevada.

Prof. Friend sends a tracing of an earthquake which occurred between 9 p. m. February 23 and 7 a. m. February 24. He says: "No one here, it seems, has felt it, and consequently cannot give you the exact time." The maximum disturbance being about E. S. E. by W. N. W., having an extreme amplitude of 17° on the plate, with a motion at right angles to this of 7 mm.

1892. February 17; Forestville, Sonoma County.

A shock.

1892. February 23; San Diego.

Earthquake shocks are frequent of late. Near midnight, February 23, the first shock, lasting seventy seconds, cracked walls of buildings, and people were thoroughly frightened, VII. Six or eight more shocks were felt that night, the second shock occurring just thirty minutes after the first one. Nearly every night since there have been one to three slight shocks. So severe was the first shock that the undulations gave many the feelings of seasick patients. Along the Pacific coast from Mexico to British Columbia slight shocks were felt, especially in Oregon and Washington.

1892. February 23; San Diego.

The earthquake which visited southern California just before midnight last night was the worst San Diego ever experienced, and seems to have been more severe the farther south it was felt. In this city a large number of buildings were cracked and the plaster was dislodged, although no houses were shaken down.

There were six or seven quakes after the first severe shock.

Reports from outside the city say that in Paradise Valley a church and schoolhouse, which were built upon stilts, were thrown down and almost totally demolished. A message from Campo says that the first shock, at 11.21 p. m., was preceded by a loud rumbling. Several sharp tremblings followed in quick succession. The rumblings and shocks kept up at intervals of twenty minutes or more through the night until 4.53 a. m., when a fearful shock, with vibrations lasting twenty-five seconds, accompanied by local rumblings, caused the inhabitants to rush out of their houses in terror. Since 5 o'clock this morning over twenty distinct shocks have been experienced, the last one as late as 10 o'clock. At Jamul the walls of the stone kilns at the cement works were cracked and other damage was done. Rumblings have been heard all day in the hills and mountains thereabouts, and the inhabitants are panic-stricken.

1892. Point Firiuni Station (San Pedro), Cal.; 11:20 p. m.

Sleepers waked; clock stopped, etc. (VI).

1892. Ballast Point Light Station (Cal.); 11:17 p. m., local time.

Direction E. S. E. to W. N. W. This shock lasted 1m. 12s. (counted); clock stopped, etc. (VI). Other shocks at 11.30 p. m. (very light); 12.15 p. m. (very light); 1.16 a. m. (heavier); 2.3 a. m. (very light); 2.35 a. m. (very light); 2.50 a. m. (very light); 3.02 a. m. (heavier); 3.19 a. m. (very light); 3.47 a. m. (very light); 3.59 a. m. (very light); 4.31 a. m. (rumbling); 5.57 a. m. (heavier). [The durations of these later shocks are all given and they are all long, from which I infer that the 1m. 12s. above *may* be too long.—E. S. H.] (Ms. kindly communicated by U. S. Geological Survey.)

1892. Point Loma Lighthouse (San Diego); 11:14 p. m. (standard time).

Lasting one minute; 11.24 p. m., lasting 15 seconds; 11.35 p. m. (light); 11.40 p. m. (light). No damage done.

Messages from Lower California are to the effect that Ensenada, Alamo, and San Quentin experienced the severest shocks within the memory of the oldest inhabitants. At Ensenada buildings swayed to and fro, and the people rushed into the streets, frightened by the unusual noises which followed the seismic disturbance. At San Quentin the Peninsular Railway roadbed sustained considerable damage. The shocks there were simply unparalleled in duration, lasting fully seventy seconds (VII?, VIII?).

1892. February 23; Palm Springs; 11h. 25m. p. m.

It lasted over one minute and the direction of the vibration was southeast to northwest. It was followed by at least eight other shocks, all exceptionally severe. The last shock was at 4.30 a. m.

1892. February 23; Indio; 11h. 16m. p. m.

A severe earthquake. There were five lighter shocks between that time and 11.45 o'clock, and there was one at 12.30 and one at 4.49 a. m. Feb. 24. No damage was done (VII).

1892. February 23; Beaumont; 11h. 20m. p. m.

A severe earthquake. The vibrations were from east to west and lasted several seconds.

1892. February 23; Pomona; 11h. 15m. p. m.

Buildings shook and rocked for a few seconds, but no damage was done; not even a glass broken. The vibration was north and south (V?, VI??).

1892. February 23; Santa Ana; 11h. 15m. p. m.

Eight shocks. The heaviest was at 11.15. The walls of the water-works building were cracked and plastering in several houses was broken. Visitors in all the hotels left their rooms and clocks stopped (VII).

1892. February 23; San Bernardino.

At 11h. 15m. a shock, lasting about one minute and a quarter. The vibrations were northeast and southwest. No damage was done, except to break chinaware and stop clocks. The shock was heavy and was followed by light temblors all night (VI).

1892. February 23; Ontario.

Two sharp shocks at 11.15. The course of the wave seemed to be northeast to southwest. There was no damage.

1892. February 23; Visalia.

A light shock was felt here at 11.40 o'clock p. m.

1892. February 23; Yuma.

Two shocks at 11 o'clock p. m. The movement was from east to west. No damage was done.

1892. February 24; San Diego.

Two more shocks were felt in this city at 2 o'clock this morning, but neither was as bad as those of the preceding night, and no damage was done. They were severe enough to cause a hasty exodus of lodgers from hotels in their night clothes (VII).

At Campo the rumbling and shocks continued last night, but no damage was done. Up to this evening there have been about eighty distinct shocks in that locality since Tuesday night. February 24, Carson City, 7 a. m.

1892. February 24; Ontario.

There were two more, but light shocks, one at 9.30 p. m. and the other at 2 o'clock a. m. The first occurred while a large audience was listening to George W. Cable at Workman Hall.

1892. February 24; Santa Ana.

Two light shocks were felt here about 2 o'clock a. m.

1892. March 1; 21h. 30m.

Kalama, Washington.—P.

1892. March 1; 3 p. m.

San Bernardino.—*Cal. S. N. Service Bulletin.*

1892. March 13; Petaluma.

This morning at 5.25 o'clock a distinct shock of earthquake. The vibration was from east to west.

1892. March 13; Napa.

This morning at 8.35 o'clock a rather severe shock. The vibrations were from north to south, continuing about twelve seconds.

1892. March 13; Napa.

This morning at 8.23 came a slight shock of eight seconds' duration.

1892. March 26; Carson City.

Slight shock recorded between 7 a. m. and 6 p. m. Slight tremors all day.—C. W. F.

1892. March 28; Drytown.

A slight shock of earthquake was felt here at 7.30 o'clock this morning. It was accompanied by a rumbling sound. The vibrations from west to east.

1892. April 3; Mount Hamilton.

Prof. Holden reports being waked by a shock. Intensity = R. F. IV. "2.45.0 \pm 4s. P. S. T. southeast and northwest. Duration, 1s. to 2s. at least. Wakened. Intensity = III-IV. In second story of brick house."

1892. April 17; Tacoma, Washington.

Two shocks were felt at 2.55 o'clock this afternoon. The second was scarcely perceptible. Buildings trembled. The vibrations were from south to north. There was a severe shock at Olympia at 2.39 o'clock this afternoon which lasted seven seconds. Intensity II at Tacoma and at Castle Rock.—P.

1892. April 17; Portland, Oregon.

At 2.50 o'clock this afternoon two heavy shocks. They lasted about ten seconds each and the vibrations were, from west to east. Many persons became frightened and rushed into the street when the buildings began to tremble. No damage.

1892. April 17; Olympia; 2:45 p. m.

Severe.

1892. April 17; Portland; 2:56 p. m.

The observer of U. S. Weather Bureau reports *one light* shock.

1892. April 19.

On the morning of this day in the central portion of the State occurred the heaviest earthquake of the year, and in the localities where it was most severe it was doubtless the worst ever experienced, rivaling that of 1868 in severity, and probably exceeding it in point of property destruction. Three important towns, viz., Vacaville, Winters and Dixon, suffered severely and much damage was done in the vicinity. The second day following brought another severe shock which wrecked many buildings already weakened. It is, perhaps, worthy of remark that these disturbances did not follow the mountain contour of the country, but seemed to have their greatest range east and west or nearly at right angles to the direction of the mountain ranges; crossing the Sierras, they were distinctly felt in Nevada. The loss of property was great.—C. D. P. It is my opinion that this shock was quite as severe as the San Francisco shock of 1868.—E. S. H.

1892. April 19; Mount Hamilton.

"Long period gentle shock—waked sleepers—swung hanging lamps—R. F. = IV to V. 2.49½ P. S. T." (Prof. Holden.) The record on the duplex seismograph shows the greatest motion to have been east and west, amounting to 18.5 mm.; the displacement north and south amounting to 8 mm.

1892. April 19; San Francisco; 2h. 50m. a. m.

Sharp undulating shock S. W. and N. E. Duration 40 seconds.—T. T. The shock was the heaviest experienced since the historic one in 1868.

The greatest result that the shake occasioned in San Francisco was the downfall of the front wall of the Old Academy of Sciences building on the corner of Dupont and California streets. Workmen were engaged in tearing it down. The roof and side walls had been cut away, and to guard against a fall the wall was braced with long timbers. When the quake came the timbers were shaken off and down came several tons of brick and mortar. The earthquake began with a thump that seemed to knock the earth to the west, then for about three seconds the world seemed to be sliding convulsively back into place. But before it came to rest there was another thump, followed by a lighter one. Altogether it took thirteen minutes for the earth to get over its fluttering. Prof. Davidson happened to be in his observatory. He did not feel the earthquake, as he was just rising from his chair. He knew it was a-quaking, however, by the excitement in the bubbles of the levels. The time was 2.51.41 this morning. The

movement in minute waves was 0.9 second of arc, and the period of the pulsations about three seconds of time and not regular, at times almost subsiding and then starting out afresh. The movement was apparently from the south. This continued for four or five minutes, and in six minutes the amplitude of the waves was



FIG. 1.—Tracing of the seismograph in San Francisco. (Magnified.)

from 0.2 or 0.3 second of arc, and the time of pulsation slower. The pulsation was faintly exhibited for nine minutes and in thirteen minutes it had ceased. At the close the north ends of the two levels were 0.5 second of arc higher than when first read.

Prof. Davidson says that this was one of those earthquakes that

roars, and was the second of that kind that he had observed. Just before the shaking there was a noise as of heavy wagons being hauled over hard ground a long way off.

A distinct shock (2.40 a. m.) W. N. W. and E. S. E. was registered at Berkeley.—Professor Soulé.

Mr. Burckhalter, of Chabot Observatory, Oakland, was ready for it, and his seismograph reduced the earth's movements to black and white. When it registered on this side the curves were replaced by erratic angles.

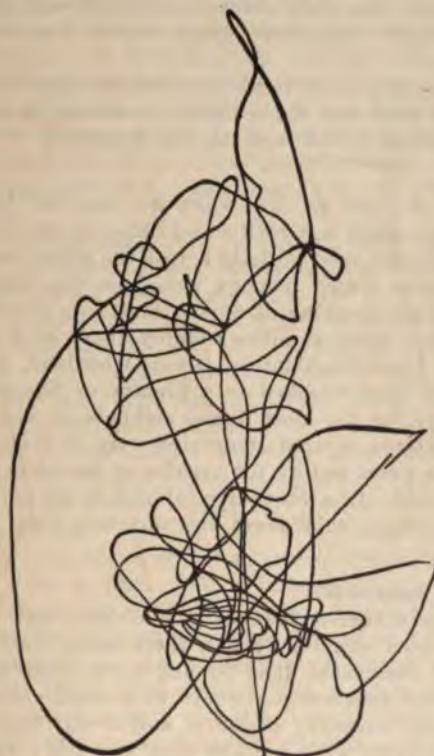


FIG. 2.—Tracing of the seismograph at the Chabot Observatory, Oakland.
(Magnified.)

The ferry depot (foot of Market Street) rocked and creaked, and those inside of it started to run for the door. Every clock in the building, including the tower clock, stopped, and all showed the same time, viz., 2.53 o'clock (VI?, VII?). On board the ships a slight trembling was felt that lasted about ten or twelve seconds. The shock was felt only by those who happened to be on deck. The ferry tower pendulum is between 50 and 60 pounds weight

and is suspended by a steel spring 6 or 8 inches long and three-fourths of an inch wide, similar in appearance to a piece of scrap iron. The shock set the pendulum to wriggling in an irregular manner from side to side and kept it up so long that the strong steel was warped in all sorts of shapes and finally broken.

The guests in the New Western hotel poured out into Kearney Street when the shake took place (VII?).

The guests in the Palace Hotel were somewhat frightened, a number of them rushing into the corridors to ascertain the cause of the vibrations. The only damage sustained was the breaking of a few statuettes and some glass, which were thrown to the floor (VI?).

The shock was very much more severe in the region 50 or 75 miles north of the city, and the residents there had much curiosity to know how great it had been in San Francisco.

1892. April 19.

The *Chronicle* of April 20: The vibration was felt from Gilroy and Fresno on the south to Oroville and Chico on the north, and from Santa Rosa on the west entirely across the State and into Nevada; the area within which damage was done was very small. This district includes portions of Solano and Yolo counties, and comprises a section some 20 miles wide by about 30 in length. Brick buildings in Vacaville, Winters, Dixon, Woodland, Esparto, Capay, and Fairfield were wrecked to a greater or less extent, but the entire damage, by the most liberal estimate, is so small that it is apparent that the injured structures were of a class easily damaged, and no great outlay for repairs or complete reconstruction will be involved. In a few cases injuries to persons are reported, but in no instance were there any seriously hurt, nor was there any loss of life.

1892. April 19; Vacaville.

An earthquake occurred here at 2.50 o'clock this morning. The damage in town was very great, there being few, if any, of the hundreds of residences that do not show evidences of the tremendous power exerted. Chimneys were razed entirely or twisted badly. Dishes, tinware, crockery, and everything of a movable nature went down with a crash that was truly appalling. This statement will as well apply to the whole township as to the town (VIII).

This town presents a strange appearance to-night. There is apparently but one street in it, namely, Main Street, and the south side is nothing more nor less than a row of wrecked brick structures, and the street is filled with pieces of brick and lumber, and the cracked edifices are propped up with huge beams to prevent them from falling into the roadway. The north side of the street was composed in the main of wooden buildings, and except in a few instances the loss on that side is confined to chim-

neys, which went by the run when the memorable tremor struck the town.

The worst cases of damage off Main Street were sustained by W. J. Dobbins, who lived in a two-story brick building about 300 yards north from Vacaville, and by Garland Gates, who lived in a similar structure 3 miles west of the city. Both of the houses were totally wrecked and several persons who were sleeping in them at the time were injured.

On entering the town from the direction of the railroad depot the first demolished building met with on the south or brick side of Main Street is H. Chittenden's grocery store. It is a complete wreck. Next to it is F. H. Hacke's hardware shop, split and rent asunder, and held together only by wooden props leaning in from the street. The bank of Vacaville, a one-story brick structure, did not suffer as extensively as its neighbors. The Odd Fellows' building, which stands next, was badly wrecked; the upper story is thoroughly destroyed, and those who had offices there are heavy losers.

Going west, the one-story brick buildings which adjoined one another were all more or less damaged. Mr. Plates's building at the western extremity of Main Street is in a deplorable condition. It is a one-story brick building. The walls, both front and rear, were knocked out, and the building may be said to be a total wreck. The buildings which suffered most are the Brunswick hotel and the Presbyterian Church. They are wooden structures and are pretty badly damaged.

The total loss in and around Vacaville is variously estimated at from \$70,000 to \$150,000. There is not a brick building on the south side of the street which was not more or less wrecked, and some of them are a total loss. The shock struck the town at just 2.49 o'clock, and lasted fully three-quarters of a minute. The vibrations were at first from southwest to northeast and then changed suddenly to north and south. Fronts of buildings tumbled into the street, chimneys were twisted and torn as if struck by a Kansas cyclone, and the entire population rushed into the streets. That there were no fatalities is little short of miraculous, though there were a number of very narrow escapes.

Vacaville seems to have been headquarters for the quake. Several have heretofore been felt here, but none ever approached this in severity. The aggregate loss in the town and township will foot up fully \$100,000.

Probably the first person in Vacaville to notice the approach of the earthquake was S. N. Bettis, the night watchman of the town. He reports that the morning was clear and starlit and that a cold breeze was blowing. He was walking down Main Street, from west to east, when his attention was attracted by a rumbling sound which came from the hills west of the town. The noise

resembled distant thunder or the roaring of water which had suddenly been let loose by the bursting of huge dam gates. In a few seconds the noise increased to a roar and the ground beneath his feet seemed to heave up.

"The motion at first was west to east," said he, "and then several violent shocks passed from north to south. I felt as if I was on the deck of a vessel during a heavy storm, and I put my hands to the ground to prevent myself from falling on my face. After that brick walls and chimneys began to fall all around and the noise for a minute or so was deafening. Occasionally I could hear the shrieks of women above the din, and soon people began to rush into the streets in their night clothes."

The ground was fissured in many places. The public schoolhouse and the college, a couple of two-story brick buildings near the railroad depot, have also been badly racked. It is thought that the upper story of the school building will have to come down.

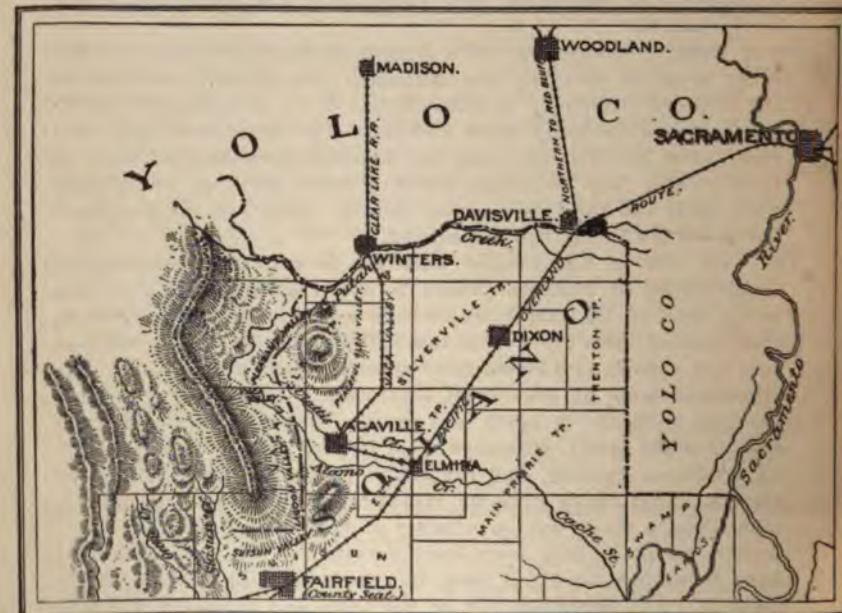


FIG. 3.—Map of Yolo and Solano counties showing the area where the earthquake was most severe.

1892. April 19; Dixon.

At 2.45 o'clock this morning people were awakened by an ominous rumbling, followed almost immediately by a heavy shock and the twisting and groaning of timbers.

Scarcely had the first vibration ceased before a second of shorter duration began. Toppled walls and crushed roofs presented

themselves on every side, and the sidewalks and streets were strewed with wreckage and debris. To add to the terror, fire broke out in several places simultaneously in the midst of the ruins. The damage will amount to many thousands of dollars. If the earthquake had occurred earlier or later there would have been numerous fires from overturned oil lamps, etc.

Many of the finest residences in town are wrecked and not more than five chimneys in the town are standing. The total loss on residences is \$6,000. In the country the loss was very serious; hardly a house rests on its foundation and some of them are not habitable. The losses to farmers will aggregate \$10,000. Every monument in the local cemetery was either broken or badly twisted and thrown from position.

There were several miraculous escapes from death.

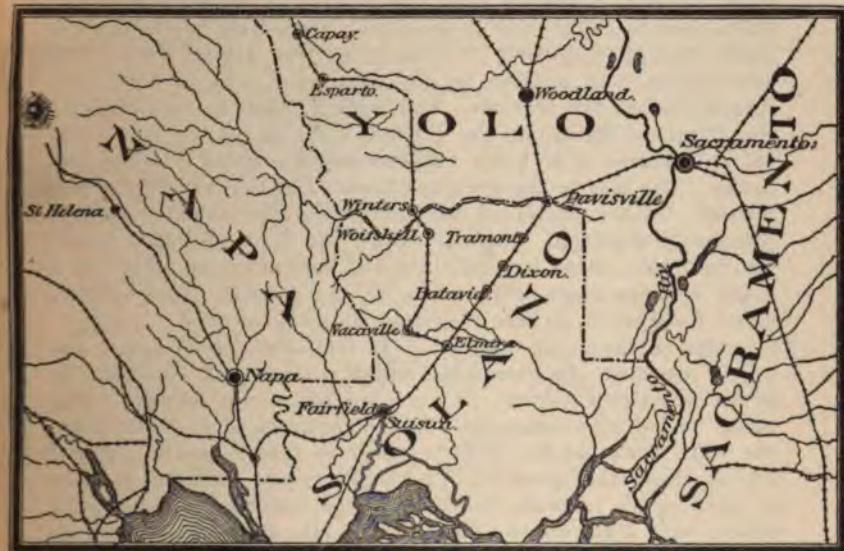


FIG. 4.—Map of Napa, Yolo, Solano and Sacramento counties: the earthquake center.

The schoolhouses are badly wrecked; one, costing \$8,000, is twisted off the foundation, and the roof has caved in. The contractors have been making estimates all the afternoon, and it is safe to say that it will cost \$75,000 to make repairs—\$50,000 in town and \$25,000 in the vicinity. The stoppage of clocks confirms the general impression that the main shock occurred at 2.50 a. m. The facts seem to show that the wave traveled much nearer the surface than in the earthquake of 1868, or even in the Napa shock of last year. Every article of glass was turned upside down and

nothing was broken; while at a saloon not half a block away the proprietor did not even know that an earthquake happened till the ringing of the fire bell summoned him to duty—not an article of glass in his place was broken or disturbed.

1892. April 19; Winters; 2h. 50m. a. m.

Every brick and stone building in the town is damaged more or less, and some of them are total wrecks.

The fine new schoolhouse, just completed, lost its chimneys; the plaster is cracked, and the brick foundation is badly shattered. It is estimated that the loss to the town will be from \$50,000 to \$60,000.

The large new Devilbiss hotel suffered considerably, much of the brick front caving into the street.

Sixty feet of the fire wall of the new Cradwick building on Main Street toppled westward upon the frame roof of Judy Brothers' stable, and crashing through completely buried six horses in their stalls, though singularly not badly hurting them. To-day the schoolhouse, just finished by the contractor, was to have been turned over to the trustees. The brick foundation was cracked, the chimneys thrown to the ground, and the plaster torn. The old schoolhouse is so badly wrecked that no school is being held to-day. The loss to the town is estimated at between \$70,000 and \$100,000. At the graveyard tombstones were wrenched around or completely shattered. Near the town the bank of Putah Creek, ten feet wide, caved in, and along the bottom of the creek for a great distance rents were made by the shocks. West of here about three miles, an acre of ground slid into the creek.

Two miles southeast of Winters, J. R. Wolfskill's stone house was totally wrecked. In Pleasanton valley a lamp in J. N. Thissell's house was thrown down. It exploded and a fire followed. The house was wholly consumed. In the residence of J. A. Devilbiss the wall was separated from the floor so that a man might put his leg down the aperture. Up the Berryessa road the passage is blocked by immense boulders, some weighing several tons, which were thrown down the hillsides into the road. It is near this point where the rents in the road were noticed. William Barker's adobe house across the creek was so shaken that it is dangerous to enter it, and other houses were wrenched from their foundations. From all around come reports of wells filling up with caving earth and narrow escapes from awful fires and death by the falling of burning lamps in sick rooms. What is most mystifying in the face of all the damage done is that no lives were lost and very little injury to persons is reported. The bank building on Main Street was wrecked. There is not a whole window left in any house on that street. In the office of the *Express* forms were pied, type emptied from the cases, and the old Washington press, weighing over a ton, knocked over. A big job press suffered similarly (VIII).

On Putah Creek, half a mile west of Winters, a phenomenon was witnessed by a young man named Fred Willis, who was riding past at the time of the big shake. There seemed to be an explosion, and the water was thrown from the creek to a distance of 20 feet on either bank. Then followed a hissing sound as of gas escaping. At daylight several fissures were found in the bed of the creek and in the roadway and fields adjoining. On each side of the creek where the explosion took place the banks caved in, the landslides being 75 feet in length and 12 feet deep.



FIG. 5.—The region affected by the shocks of April 19, 1892.

Such as were enabled to see the sky through split roofs after the big shock passed state that the heavens were livid with fire, and when they reached the street there seemed to be a haze in the atmosphere, while odors of sulphur were distinctly discernible. The people of Winters are extremely positive on these points.

1892. April 19; Woodland.

A deep rumbling noise at 2.45 a. m. to-day was the forerunner of the most severe shock of earthquake ever experienced in this portion of the State. The shock was a series of rapidly intermittent vibrations which lasted for thirty seconds, at first almost north and south and changing frequently from east to west, producing the impression of circular motion. Fortunately the casualties in this immediate vicinity are not great, but the public never experienced a worse fright.

Evidences of the force of the shock are numerous everywhere. Chimneys are cracked and occasionally toppled over, brick walls are cracked and fire walls suffer through loss of brick. The destruction of glass in stores and private residences is very large. The Byrnes Hotel loses a part of its ceiling; the Capital Hotel, a chimney; Masonic Hall suffers in chimneys and plaster; Mezgar's bakery furnishes broken glass and cracked walls. The grammar school building suffers a broken fire wall and cornice. So far there is no evidence of any damage to the waterworks. In the Croft Hotel a number of the rooms are almost denuded of plaster, and most of the business blocks are slightly damaged. One of the Capital Hotel chimneys is out of plumb. The walls of both the jail and court room are cracked. The plastering has fallen off in Superintendent's Banks's office. The wall at the southwest corner of the Bank of Woodland is cracked. At the Byrnes Hotel the walls were cracked and the plaster fell to the floor in several rooms. Many of the guests were so badly frightened that they ran downstairs without stopping to dress (VII?, VIII??).

1892. April 19; Grass Valley.

This morning a little before 3 o'clock two shocks of earthquake woke the people and rattled things. The direction was north to south. No damage was done (VI).

1892. April 19; Auburn.

There was an earthquake this morning about 2.45. There were two distinct shocks, about ten seconds apart. The course was northwardly. No damage is reported.

1892. April 19; Chico.

A heavy shock of earthquake was experienced in this city at 2.45 this morning, followed immediately by two others. They seemed to pass northwest to southeast. Many clocks in the city were stopped. In some places articles sitting near the edges of shelves were knocked off. No damage was done to the windows or glassware (V).

1892. April 19; Stockton.

A severe shock of earthquake was felt here at 2.50 o'clock this morning. No damage is reported, but the fright was great (V? VI?).

1892. April 19; Nicolaus.

There was a severe earthquake at 2.50 o'clock in the night. The direction was doubtful. A loud rumbling noise followed the shock.

1892. April 19; Merced.

Two distinct shocks. The first occurred at 2.47, stopping the clock at El Capitan Hotel. The second shock was three minutes afterward starting the clock again. No damage was done (VI).

1892. April 19; Marysville.

The duration of the shock was from seven to nine seconds. The vibrations were north of northwest and south of southeast. It was the severest and longest of any ever experienced in this vicinity, but did no damage. Buildings were swayed, bells rung, and clocks stopped.

1892. April 19; Nevada; 2h. 50m. a. m.

Two sharp shocks. The first was of brief duration, but the second, which immediately followed, lasted eight or ten seconds, awakening the soundest sleepers and creating widespread alarm among timid people. The vibrations extended from northeast to southwest (VI).

1892. April 19; Folsom.

The prisoners in the jail were greatly alarmed at the earthquake shocks. No material damage resulted.

1892. April 19; Antioch; 2h. 45m. a. m.

A severe earthquake shock. The vibrations were from west to east and of about forty seconds duration. No damage to property.

1892. April 19; Benicia; 2h. 40m. a. m.

The heaviest shock of earthquake felt in this city since 1868. The vibrations lasted for several seconds and were north and south. The whole town was aroused. Little or no damage is reported here beyond the cracking of a few chimneys and some plastering (VII?).

1892. April 19; Davisville.

The hardest shock of earthquake ever experienced here was felt this morning, but the damage is very slight. One or two chimneys were overthrown and brick houses cracked, but not so as to be dangerous. Perhaps \$200 will cover all damage.

1892. April 19; El mira.

The most severe shock of earthquake ever experienced here occurred this morning at 2.50 o'clock, destroying almost every chimney in the town, and badly wrecking the brick store of J. Allison & Co. The damage is small, as the buildings are all frame (VIII).

1892. April 19; Colusa.

At 2.50 o'clock one of the heaviest shocks of earthquake ever felt at Mills station occurred, lasting about twenty seconds. The vibrations were from north to south.

There were several severe shocks. Opinion is divided as to the direction. Clocks were stopped and there was a general shaking up of crockery (VI).

1892. April 19; Wheatland.

The vibrations appeared to be west to east, and were so pronounced as to awake the soundest sleeper (VI).

1892. April 19; Orland.

Two distinct shocks were felt here about 2.40 a. m. The vibrations were apparently north and south.

1892. April 19; Biggs.

Three heavy shocks occurred here this morning at 3 o'clock. The vibrations were northeast and southwest. Clocks were stopped and plastering cracked (VI).

1892. April 19; Petaluma.

About 2.55 o'clock one of the heaviest and longest earthquake shocks experienced here for some time. The vibration was from east to west, and the duration three to four seconds.

1892. April 19; Suisun.

The severest earthquake ever experienced in this vicinity occurred at 2.52 this morning. The shock, although very severe in Suisun, was not nearly as hard as it was a few miles north and east of town. The principal damage here was to the new Masonic Hall, where the plastering is very badly tumbled down and cracked (VII).

The Methodist Church in Fairfield is so seriously damaged that it will have to be taken down. The bell tower is all down, and the walls of the building so badly cracked and broken as to render it unsafe. The court-house and jail were also slightly injured.

There were also a large number of brick chimneys in Fairfield leveled to the tops of the houses (VII?, VIII?).

The vibrations appeared to be from the northwest to southeast and lasted fully one minute. The damage in this town and immediate vicinity, with the exception of the church in Fairfield, will not exceed \$500.

1892. April 19; Sacramento.

Some attempts have been made to make a sensation of the earthquake shock here this morning. The truth is the only damage done was the shaking down of one old chimney and the breaking of a chandelier pipe which had rusted at the ceiling joint. Even

pyramids of wine glasses in the show windows of the crockery stores were not disturbed. In a few old buildings a little plastering was loosened. The shock was lively enough and many persons were frightened, but that was all (VI).

1892. April 19; Fresno.

A shock of earthquake was felt this morning at 2.45 o'clock. No damage was done, the shock being slight, and only sufficient to rattle dishes and disturb those who do not sleep soundly. Not one person in ten felt the shock (IV?)

1892. April 19; Reno, Nevada.

A slight earthquake shock occurred here this morning at 2.50 o'clock. The vibrations were from north to south.

1892. April 19; Virginia, Nevada.

The earthquake was felt here. The vibration was from east to west, but no damage is reported.

1892. April 19; Carson City, Nevada.

Reported by Prof. C. W. Friend as occurring at 2.50.40 a. m., P. S. T. Duration, 30 seconds. The tracing shows a total displacement of the pointer in a northeast and southwest direction of 49 mm., and a displacement in a northwest and southeast direction of 29 mm. (VI); stopped two clocks in the observatory. Gentle, large movement.

1892. April 19; Alameda.

Tracing made by duplex seismograph shows a total displacement in a northeast and southwest direction of 30 mm. and in a northwest and southeast direction of 26 mm. Time, 2.49 a. m.—C. D. Perrine.

1892. April 19; Smith Creek, at the foot of Mount Hamilton.

Time noted by Mr. King, $2.50 \pm \frac{1}{2}$ minute p. m. Prof. Holden reports King's watch right at 10 a. m.

1892. April 19; Willows.

A severe shock at 2.51 o'clock, lasting fifteen seconds. Scores of people are practically homeless here. Reports received within a radius of 5 miles around place the amount of damage up to \$200,000, at a moderate estimate.

1892. April 19; San José.

An earthquake of considerable length occurred about ten minutes to 3 o'clock this morning, but it was not severe enough to cause any damage in this city. Its duration was about forty seconds and the vibrations were from east to west. It was not felt by everybody. It started with a jerk and then settled into a trem-

bling with an evenness that seems remarkable and was the cause of much comment. As one person expressed it, "It seemed as if a cradle was rocking."

1892. April 19; Esparito.

The severest earthquake that was ever experienced in this locality took place at 2.50 a. m. to-day. Considerable damage was done, though fortunately no one was injured. The greatest damage was done to the Barnes Hotel. A section of the east wall fell down and a great deal of plastering fell in the rooms. Three chimneys were knocked down, one of them crashing through the roof.

It will take \$1,500 to cover the damage to the hotel. The fire walls of Levy and Schwab's building were displaced 5 inches. There was also loss from damaged goods and broken crockery (VII?, VIII??).

The large grain warehouse at this place was also slightly wrecked and the drug store considerably damaged. Other buildings were more or less damaged. The earth opened in several places between here and Capay.

1892. April 19; Capay.

The earthquake gave the town of Capay a lively shake-up. The west wall of B. Waldrich's building caved in and the east wall fell out. The damage is fully \$1,000. The stock of merchandise in stores was thrown down from the shelving. The walls of the Nash building were cracked and nearly all the chimneys in the town were thrown down (VIII).

1892. April 19; Santa Rosa.

The earthquake which visited Santa Rosa this morning at 2.50 o'clock was the most severe felt since 1868, and many think it was worse than that. It lasted over a minute, and the vibrations seemed to be of an undulatory nature east to west, and lasted three minutes. Windows were broken in many houses and plaster was torn from some of the houses. A panic prevailed at hotels, guests getting up and running out in their nightgowns. No very serious damage was done (VII).

1892. April 19; Martinez.

This morning about ten minutes to 3 o'clock one of the severest shocks of earthquake ever felt here awoke the slumbering residents. The vibrations seemed to be from west to east, although some seem to think they vibrated from north to south, and lasted about thirty-five seconds. A few cans toppled over in some of our stores, several clocks stopped, a few cracks occurred in the court-house plastering, and several chimneys were shattered (VII).

1892. April 19; Fairfield.

The hardest shock of earthquake ever experienced here occurred at 2.50 a. m. The vibrations were northeast and southwest. Windows and glassware were broken and the stoves and bookcase in the schoolhouse were overturned. The bell tower on the brick Methodist Episcopal Church fell in and the gable end on the north side fell out. The church was ruined. The courthouse and jail were not much damaged. (VII?).

1892. April 19; Napa.

A heavy earthquake shock was experienced here about 2.50 this morning, followed within half an hour by two lighter shocks. The vibrations were east and west, continuing several seconds. People very generally were alarmed, but no damage was done. The shock was the heaviest felt in several years, excepting that of last October.

1892. April 19; Healdsburg.

An earthquake visited this section at 3.10 o'clock this morning. It was one of the most severe shocks ever felt in this locality. The vibrations seemed to be from south to north. There were three distinct shocks, the first being the most severe. The last of them seemed to take a rotary motion. The plaster in several stores was badly cracked (VII?).

1892. April 19; San Rafael.

The severest earthquake shock experienced here in a number of years occurred this morning at 2.50 o'clock. The vibrations were from north to south and the shock was perceptible for about fifteen seconds. No serious damage was done here, but in numerous residences clocks were stopped, crockery thrown from shelves, and water pipes wrenched (VI).

1892. April 19; Marecuse.

The severest earthquake that has been felt in this neighborhood for years occurred this morning at about 3 o'clock and lasted for nearly half a minute. The vibrations were from north to south. No damage has been heard of.

1892. April 19; Vallejo.

The earthquake this morning stopped the two standard clocks in the Naval Observatory at Mare Island, it being the first time they were ever so affected. The heavy mercury pendulum of one of the clocks was swung out on the ledge of the case and was removed with difficulty. The transmitting clock was not stopped (VI).

1892. April 19; Milton.

At 2.45 o'clock this morning two heavy shocks were felt here. The vibrations were southwest to northeast. Buildings trembled and many persons were severely frightened, but no damage was done.

1892. April 19; Placerville.

A very distinct shock of earthquake was felt at 2.50 o'clock a. m. to-day. The vibrations were from east to west.

1892. April 19; Ukinh.

No seismic disturbance occurred in this section.

1892. April 19; Bonita Point Lighthouse; 2:47 a. m.

Sharp shock. Mare Island L. H., 2.47 a. m., wakened sleepers (VI); duration 30 seconds; rumbling noise followed by a shock W. to E. Fort Point L. H., 2h. 51m. 15s., lasting 7 seconds. A "moderate" shock, though it awakened the observer. Many did not feel it (V?). Roe Island L. H., 1h. 50m. a. m., railroad time [should be 2.50]; a severe shock lasting (by watch) fully 45 sec. Brick chimneys thrown down; but L. H. clock not stopped, though disturbed (VII?).

East Brother L. H., 2.50 a. m., lasting 47 seconds, E. to W.; not heavy. Lime Point L. H., 2.52 a. m. (clock regulated by noon time-ball in S. F.); duration about 8 seconds. A tremor rattling windows, etc. (IV?). Oakland Harbor L. H., 2.45 a. m., a strong shock from the W., lasting 5 sec., "shaking dwelling terrifically, etc." (VII?). Yerba Buena L. H., 2.50 a. m., lasting 58 seconds. A very heavy shock.

Angel Island L. H. Felt on the island, but not at the L. H.

1892. April 20; Roe Island Lighthouse, 1:50 a. m.

Slight shock. (The foregoing reports from lighthouse keepers are kindly furnished by the U. S. Lighthouse Board, through the U. S. Geological Survey.)

1892. April 20; Vacaville.

When the terrible shock of Tuesday morning occurred every one expected a repetition. During last night there were constant shocks, beginning about midnight and continuing to 8 this morning. The only effect of to-day's quakes has been to weaken the walls already shaken.

The townspeople of Vacaville have had seven more shocks to unnerve them. The heaviest came a little before 2 o'clock this morning and shook down several walls which were already tottering, but did no other damage. No one has been hurt since the big shock. It is safe to say now that the danger is over, and that it will take \$100,000 at least to repair damages.

1892. April 20; Petaluma.

About 10 minutes to 2 o'clock this morning a quick, sharp shock of earthquake passed through Petaluma.

1892. April 20; Napa.

Another shock of earthquake was felt here this morning about 2 o'clock. It was much lighter than that of Tuesday morning. No damage was done.

1892. April 20; Martinez.

A slight shock of earthquake was felt here this morning about 6 minutes past 2 o'clock, but did no damage.

1892. April 20; Stockton.

Timid people who were frightened by the sharp earthquake shocks at 2.50 o'clock Tuesday morning noticed two more gentle tremors at 2.05 this morning. No damage was done.

1892. April 20; Woodland.

There was a slight shock at 2.05 o'clock this morning. No damage.

1892. April 20; Grass Valley.

There was a shock here this morning at about 2 o'clock, lasting twelve or fourteen seconds. No damage.

1892. April 20; Nevada City.

Mild shocks were felt here at 10 o'clock last night and at 2.05 o'clock this morning.

1892. April 20; Suisun.

There were three slight shocks here to-day, the first occurring shortly before 2 o'clock this morning and the last at about 8.30.

1892. April 20; El mira.

Seven fresh shocks, the heaviest at 2 a. m. and the last at 9 a. m. The vibrations were northeast and southwest. Most of the chimneys went down on Tuesday morning and no further damage has been done.

1892. April 20; Fairfield.

Fairfield had another shake-up to-day, the most noticeable tremor being at 2 o'clock this afternoon. No damage.

1892. April 20; Napa.

Another shock was felt here this morning about 2 o'clock. It was much lighter than Tuesday morning's. No damage.

1892. April 20; Sacramento.

Mild shocks were felt here at 10 o'clock last night and at 2.05 o'clock this morning.

1892. April 20; Winters.

Three small shocks. The hardest was at 2.05 o'clock; the second came a little before 4.30 o'clock and the third at 8.40 a. m.

At Winters there have been developed a number of fissures in the earth, water has been ejected, gas has escaped, and the bed of the creek has been filled up for a distance of over 70 yards. Many of the wells have been filled up by the collapse of the walls.

1892. April 20; Dixon.

This town has had three more shocks since the big one of yesterday, but the people are regaining confidence. Most of the brick buildings that were damaged by the first shock will have to come down.

The shock which came at 2 a. m. was heavy, and it was followed by another of a milder sort at 4 o'clock. At 8.30 o'clock came a third, which was felt lightly all along the line to Benicia.

1892. April 21; Davisville.

At 9.43 this morning another severe shock was felt at this place, the vibrations running from southeast to northwest. It was of brief duration, lasting no more than five seconds, yet in severity it seemed to exceed that of the morning of the 19th. The additional damage is scarcely noticeable. In a drug store several bottles were thrown from the shelves and the glass was crushed in the front. The shocks, fortunately, passed quickly and without the gyratory motion mentioned in that of the 19th, and to these circumstances we are indebted for our slight loss. Families living in brick buildings are looking for other and less dangerous quarters. Many brick chimneys will have to be torn down and rebuilt.

1892. April 21; Winters.

Another slight shock of earthquake was felt here at 3.05 o'clock this morning. No damage resulted.

Another shock of earthquake occurred here at 9.40 o'clock, throwing down the Masonic Hall, Cradwick's building, Bertholet's two-story stone building, Humphrey Bros.' one-story stone building, and generally demolishing goods, fixtures, etc. One man was badly hurt by a falling wall, and Miss Clara Jessen was hurt. Others were more or less injured. Business is all suspended. Main Street is a scene of desolation. A fire broke out but was extinguished.

J. Devilbiss's house, 1 mile west of here, is a total wreck; also Mr. Baker's adobe and J. R. Wolfskill's stone dwellings.

1892. April 21; Woodland.

The shake at 9.40 a. m. continued for thirty seconds. The vibrations were from east to west. The actual damage was not great, but many buildings were wrenched and weakened. Byrnes's Hotel is seriously damaged, the fresco broken, and the walls cracked. Nobody was injured in town. The chimneys on the top of the court-house were rendered unsafe and have been taken down.

The walls of the county jail were badly cracked. The upper story of the Thomas building was badly cracked and the city prison has been rendered unsafe. The Exchange and Craft hotels were

both badly damaged. On Main Street the two-story brick school building was cracked. Experts have examined the building and report it unsafe. Two large plate-glass windows in the Medal bakery were broken. All the stores sustained some loss from the breakage of bottled goods, china and glassware.

Many chimneys were twisted and overturned. The general loss is estimated at \$5,000. The wildest excitement prevailed at the time of the shock.

1892. April 21; Nevada City.

At 9.44 o'clock this morning a series of earthquakes, lasting forty-five seconds, were felt here. The waves were from S. to N. The first four were so sharp as to attract the attention of persons afoot and then gradually diminished in force. Doors and windows rattled and some clocks stopped (VI). No damage was done in this section. There was another shaking up shortly after 9 o'clock last night.

1892. April 21; Marysville.

This morning a slight shock at 9.43 o'clock. The vibrations were north and south. One of the public-school buildings was slightly damaged—that is all.

To-night at 7.15 o'clock another shock.

1892. April 21; Grass Valley.

At 9.35 o'clock this morning quite a heavy shock occurred. It sent everybody into the streets. Several brick buildings in the town are cracked (VII?).

A very sharp shock occurred at 7.25 this evening.

1892. April 21; Placerville.

A sharp shock, followed by slight tremors, was felt here at 9.43 o'clock this forenoon. The course was apparently from west to east. No damage to property.

1892. April 21; Chico.

Another heavy earthquake was felt here this morning at 9.47, lasting thirty seconds. The vibrations were north to south. Lamps in buildings all over the city were set swinging. The ceilings in some places cracked and clocks stopped (VI). No damage is reported.

1892. April 21; Biggs.

A very heavy shock occurred here this morning at 9.45. The vibrations were north and south, lasting about eight seconds. Eight distinct vibrations were felt. Clocks stopped and plaster fell (VII?). No serious damage is reported.

1882. April 21; San Francisco.

Quite a sharp shock was felt in this city this morning a few minutes before 10 o'clock. The temblor appears to have extended over a good portion of the central and northern part of the State, though, happily, in most sections no damage was done. In Solano and Yolo counties, however, the destruction was considerable. The town of Winters appears to have suffered most. The earthquake felt in this city to-day extended over a wide area. The disturbance was felt as far east as Reno, as far north as St. Helena, and as far south as Fresno. According to reports, it was of longer duration in the interior than in this city, where the period of vibration was not less than three nor more than six seconds.

Upon the question of duration there is the testimony of two experts with chronometers at their elbows. Mr. F. W. Edmonds, who is employed in the Geodetic Survey Office, noted the time as follows:

	h.	m.	s.
Beginning	9	42	27.4
Ending	9	42	30.2

He noted further that the direction of the vibrations was from east to west.

Thomas Tennant, the well-known nautical instrument maker, was standing with his face to a chronometer. His record is as follows:

	h.	m.	s.
Beginning	9	42	30
Ending	9	42	36

Vibrations east and west. Rolling shock.—T. T.

Those in the upper stories of buildings were the most startled, and the effect upon the majority was to make them hasten to their doors, reaching there, however, only in time to appreciate that the critical moment had passed and they were safe. The average shock is very sensitive to jars of any kind, and the earthquake stopped the swing of many a pendulum (V). But no serious damage is reported from any part of the city.

"A light shock was felt in this city at 7.14 p. m. Duration 2 sec."

—T. T.

1882. April 21; Vacaville.

Another earthquake was felt this morning, not so severe as those of the preceding days. Some shaky walls were demolished and a number of ceilings cracked, but no serious damage is yet reported. Slight shocks were felt at 6.15 and at 7.23 this evening. There was no special damage done, though the people were much frightened. Governor Markham has sent twenty-five tents. Occupation of tents is general.

1892. April 21; Martinez.

This morning at 9.44 o'clock a heavy shock was felt here, frightening the residents to such an extent that almost every one rushed into the street. The vibrations were from northwest to southeast and lasted for thirty-five seconds. Clocks were stopped in some parts of the town, the vibrations seeming to be stronger in the level than on the slopes. The court-house was cracked in one or two places, but not seriously (VII). The brick building used by the free library was cracked so badly that it is considered unsafe. The teachers in the public schools, with the exception of those in one room, became terrified, and told the children to run out of doors, and, in the mad rush, one or two were hurt, but not seriously. No other damage has been reported.

1892. April 21; Elmira.

At 9.40 o'clock this morning there was another very severe shock, badly frightening the people, but doing no damage.

1892. April 21; Benicia.

Quite a pronounced shock was felt here this morning at 9.43. It was nearly as heavy as that of Tuesday morning. Windows rattled, and buildings swayed in a sickening manner. No damage was done here, however. There was a slight shock yesterday morning about 2 o'clock.

Another severe shock occurred at 7.13 o'clock this evening. It was, if anything, more severe than that of this morning.

1892. April 21; Napa.

A heavy shock of earthquake was felt at 9.42 this morning. The shock was even heavier than that of Tuesday morning. Several brick buildings were cracked, and much plaster fell. Nobody was hurt, and no serious damage was done. The vibrations were east and west.

Another shock was felt here at 7.13 o'clock this evening. It was heavy, but no damage was done.

1892. April 21; Petaluma.

At 9.43 o'clock this morning two sharp, quick shocks passed through Petaluma from east to west. The first was light, but was instantly followed by a much heavier shock. Clocks were stopped, and some plastering was shaken down (VI?). Almost everybody went into the streets. Another slight shock occurred to-night at 7.13 o'clock.

1892. April 21; Sonoma.

A shock was felt here this evening at 7 o'clock.

1892. April 21; San Rafael.

A slight shock was felt here this morning at 9.43 o'clock. The vibrations were from north to south. There was another slight shock this evening at 7.10 o'clock, but no damage is reported.

1892. April 21; Sacramento.

A shock was felt here at 9.42 o'clock this morning. The State capitol building was slightly damaged. In the assembly chamber the ceiling was badly cracked, and two statues were thrown from their pedestals. Personal injuries were few (VII).

1892. April 21; Stockton.

At 9.43 this morning Stockton was visited by another shock, which rattled the windows, swung chandeliers, and caused people to run into the streets. No damage was done (VI).

1892. April 21; Woodland.

At 9.46 this morning a low, rumbling sound warned the people of Woodland of the approach of another earthquake, and in less time than it takes to write it the streets were filled with frantic people rushing pell mell in search of a place of safety.

1892. April 21.

The shock was felt with more or less severity at the following points: Colusa, Willows, Marysville, Elmira, Benicia, Chico, Biggs, Merced, Livermore, and Haywards.

1892. April 21; Winters.

A shock this morning has almost completely laid Winters in ruins. Buildings that were damaged Tuesday are entire wrecks and the streets are strewn with debris of the destroyed structures. Seven people were injured (VIII).

1892. April 21; Dixon.

At 9.45 this morning we had a very hard shock of earthquake. Buildings swayed, and the crashing of brick and noise was—(At this juncture the operator who was sending this item added: "I can't stay here any longer as this building is liable to fall any minute.")

1892. April 21; Maxwell.

A heavy shock was felt here about 9.45 o'clock this morning, lasting thirty seconds, vibrations east to west. No damage was done.

1892. April 21; Sacramento.

At 9.45 a. m. a severe shock occurred. The duration was about nine seconds.

Many chimneys came crashing to the ground and glass doors and windows were badly shattered (VIII?).

1892. April 21; Sacramento.

A couple of loose plaster statuettes on the wall of the capitol were thrown off and a small piece of plastering in one room fell. There was no other damage in this city except that two or three old chimneys tipped over. The shock did not exceed three seconds and was east to west and sharp (VII?).

1892. April 21; Esparto.

A terrible shock of earthquake took place here this morning at 9.40 o'clock, completely leveling the brick portion of the town. Every brick chimney was thrown to the ground and wooden buildings were wrenched out of shape (VIII).

An engineer was seriously, if not fatally, injured by a portion of the walls of the blacksmith shop falling on him.

Levy & Schwab's brick store is almost a complete wreck. The entire fire wall and part of the east and west walls are down. Loss to the building and contents, \$5,000. The Barnes Hotel suffered severely and has a hole 8 by 6 in the east wall. The bricks crashed through the roof and floor of the balcony and the cement walk was torn out of shape. The loss is \$2,500.

1892. April 21; Suisun.

The shock of earthquake this morning did great damage in this vicinity. The brick residence of J. M. Baldwin at Rockville was wrecked, while the stone mansion of L. B. Abernathie and those on the Barbour and Sproul ranches were rendered unsafe for occupancy. The stone church in Suisun valley was also greatly damaged. The plastering in the court-house was ruined, while the walls are considerably cracked. The front wall of the Masonic Temple was also damaged. The few brick chimneys in Suisun valley which withstood the shock of Monday night were all toppled over this morning (VIII).

At 7.15 o'clock this evening another severe shock occurred and twenty minutes later another milder quake followed.

1892. April 21; Healdsburg.

Another severe shock was felt in this city at 9.45 o'clock this morning. The shock was fully as severe as the one felt on Tuesday morning.

1892. April 21; Carson, Nevada.

Two more earthquake shocks have been felt here to-day, one at 9.44 a. m. and another at 7.17 p. m. No material damage has been done in Carson City by any of the three shocks.¹

1892. April 21; Reno, Nevada.

A slight shock was felt here this morning at 9.45.

¹ 9.44 a. m. E. W. (VI) and 7.17 p. m. (IV), E. W.—C. W. F.

1892. April 21; Lodi.

A shock was felt here this morning about 9.45 o'clock which lasted for fully fifteen seconds. It was not so hard as Monday night's shock. The oscillation was from northeast to southwest.

Another earthquake was felt here this evening at 7.17 o'clock, causing every one in the brick buildings to leave in short order (VI). The one this morning was so heavy it rang the school bell and shook buildings so hard that the plastering fell from several buildings, but none are badly damaged (VII?).

1892. April 21; Acampo.

Quite a severe shock occurred here at 9.45 o'clock this morning. The vibrations were from east to west, lasting about thirty seconds.

1892. April 21; Fresno.

A sharp shock was felt here at 9.46 this morning. It was from northwest to southeast.

1892. April 21; Stockton.

Quite a heavy shock was felt here this morning at 9.45, lasting about ten seconds. The vibrations were from north to south.

Another sharp shock was felt this evening at 7.15 o'clock. Crockery rattled in the dwellings and gas fixtures swung in the stores, but no damage was done (IV?).

1892. April 21; Lathrop.

This place was visited by three distinct shocks to-day; two in quick succession this morning at 9.43 o'clock, and one this evening at 7.15 o'clock, lasting twenty-five seconds. No damage whatever resulted.

1892. April 21; Reno, Nevada.

Mr. C. W. Irish reports as follows: "It occurred at 9.44.15 \pm 3s. a. m., one hundred and twentieth meridian time. The direction of the movement was apparently from N. 40° W. towards S. 40° E.; was gyratory, giving a sharp twist to chairs in which persons happened to be seated, and was accompanied by a muffled sound, which seemed to come from the summits of the Sierra Nevada mountains in the exact direction from which the waves came, and preceded them two or three seconds in time. The waves of motion were three in number, lasting about five seconds. No damage was done beyond throwing books from shelves and tables and the displacement of other articles of household furniture." (V).

1892. April 21; Mount Hamilton.

Prof. Holden reports a shock at 7.14.59 p. m., P. S. T. Intensity = III on the Rossi-Forel scale. (It was stronger than this in San José.) Registered on duplex seismograph. Started the clock of the larger machine at 7.31.23, P. S. T., p. m.

The duplex seismograph gives a tracing of the shock at 7.14.59 p. m., with a displacement of the pen in an east and west direction of 4.8 mm., and north and south of 2 mm. It also gives a tracing of the shock occurring at 9.45 a. m., with a displacement of the pen in an east and west direction of 6 mm., and in a north and south direction of 3.2 mm.

1892. April 21; Berkeley.

Principal vibrations N. and S. and E. and W. Duration 10 sec.—Professor Soulé.

1892. April 21; Carson City, Nevada.

Prof. C. W. Friend sends tracings of two shocks occurring at 9.44 a. m. and 7.17 p. m., the former showing a displacement of the pointer of 24 mm. in a north and south direction, and of 25 mm. in an east and west direction, the latter having a displacement of the pointer of 4.5 mm. in a north and south direction, and 6 mm. in an east and west direction.

1892. April 21; Mills College.

Tracings from this station at 9.46 a. m. give a displacement of the pointer in an east and west direction of 23 mm., and in a north and south direction of 16.5 mm. The tracing at 7.15 p. m. shows a displacement in a northwest and southeast direction of 14 mm., and in a northeast and southwest direction of 7.5 mm.

1892. April 21; Oakland.

Chabot Observatory.—Mr. Burekhalter reports a shock at 9.44 a. m., P. S. T., as timed by Mr. F. H. McConnell, lasting fifteen seconds, but doing no damage. The tracing shows a displacement of the pointer in an east and west direction of 14.5 mm., and in a north and south direction of 11 mm. Another shock is also reported as occurring at 7.15 p. m. \pm 2 m., with a duration of five or ten seconds, and causing no damage. The total displacement of the pointer in a southeast and northwest direction of 8.5 mm., and in a northeast and southwest direction of 3 mm.

1892. April 21; Winters.

"The state of affairs in Dixon is bad enough, but in Winters it is simply deplorable. All the lights are out for fear of fire; the hotels and even the saloons are closed, and at this moment a crowd of haggard-looking men and terror-stricken women are standing around a car on Railroad Avenue awaiting the distribution of tents. No one dreams of sleeping in any brick house, and few of the frame houses are safe.

"Two tourist cars came on the same train, having been sent by the railroad company from San Francisco for the accommodation of the homeless ones who cannot get a tent. The work of setting up these tents is going on while I write. A few hand

lamps seem only to make the darkness visible, and it is slow work at the best. There will be many who are too weary to set up the tents, and scores of people are stretched on the ground and even on the doorsteps, too tired to heed the danger of another shock.

"To-day's trouble began at 9.40 a. m. The buildings which had been badly shaken by the Tuesday tremor collapsed at once, and those which had stood the test so long began to yawn, to creak, and to open out in a manner terrible to witness. The north end of the Masonic Temple fell with a crash. Next, the Cradwick building fell in, and the Morrison building followed. All these structures are on the north side of Main Street. On the opposite side the shock caused the Berthollet stone building to collapse, and the Humphreys building shared the same fate. The Devilbiss Hotel, already badly shaken, caved in completely, the front of the bank building dropped, and the pier fell out.

"Among the victims of this shock were a man named Darby, who had his skull fractured, and Miss Clara Jessen, who was badly hurt.

"In the vicinity of town several fine dwellings are utterly wrecked. Main Street is about 400 feet long, and most of the structures are of brick or brick and stone. Not one of them is left in a habitable condition, and it is needless to say that every article of glass and crockery all along this street has been smashed to pieces. The railroad track is all right, and telegraphic communication has been uninterrupted, but there are many nasty cracks and fissures in the roadways, and driving is dangerous.

"The previous estimate of the damages of about \$75,000 or \$80,000 will have to be increased about 50 per cent. as the result of to-day's shock. The atmosphere is perfectly still, sultry, and oppressive. It may be fancy only, but one feels in breathing it a sense of impending calamity.

"The chief danger is from fire, and this has been guarded against as far as possible by a house-to-house inspection and a cry of "Lights out" wherever an offending glimmer is seen.

"The hotels have been shut up entirely; in fact, it is dangerous to enter them. A bakery and restaurant on Main Street contains a supply of provisions, but it is as much as a man's life is worth to enter it. The proprietor, Peter Graham, has been feeding the people as well as he can during the day, but the street itself is closed in.

"It is quite unnecessary to add that nothing of an exaggerated or alarmist character has been infused into this dispatch. Things are so bad that exaggeration is well-nigh impossible.

"There has been no shock since that at 7.30 p. m., but the suspense is even worse than the shock. It is now 11 o'clock, and as I look down Railroad Avenue I still see the weary ones struggling to

put up the tents. By the light of to-morrow's sun the place will look like an encampment in a ruined city.

"The first object I was shown was the calaboose or jail. There was one man in it, a tramp, when the shock came. He escaped with his life and they let him go on general principles. The jail would be improved in appearance if it had a roof and walls. In the Cradwick building there were three women and a man when the shock came. The women escaped by the front door in the nick of time. The man was the poor fellow sent with a crushed skull to Woodland. The building itself is a heap of bricks, unsymmetrically piled in the center of the lot on which it stood. Morrison's hardware store, next door, has the walls standing, and that is all. By a side alley Main Street was reached, and here the havoc wrought could only be compared to the aspect of Paris during the last days of the Commune. The most furious bombardment could have done no more. Substantially built structures were demolished even more completely than those of lighter order. Some of the granite blocks lying on the sidewalk measured two feet by one, and as for safes and similar heavy objects, they had been tossed about like chaff.

"The encampment was visited. Some of the men were laughing for fear they should cry, and all of them preferred to sleep on the ground with a friendly blanket between them and mother earth, lest they should fall out of bed. Sixteen women were found sleeping in one tent.

"It is quite clear that the focus of to-day's disturbance has been shifted to the north, and has been located near Winters. Elmira and Vacaville got off lightly. The direction of the shocks has also perceptibly changed. It must have been a fearful shock. The sand bars in Putah Creek near Winters opened and from the fissures the water spurted high up on the banks. In some places the creek became dry, in others it changed to a torrent. The banks caved in some places and almost dammed the stream. Some of the farmers say that the earthquake was foretold by the action of the fowls and animals. Horses were restive and neighing, chickens fluttered all about, and dogs whined anxiously for some minutes before the earth trembled. It was reported that several boiling springs had burst from the foothills on the north and west and were flowing steadily. Frame houses did not suffer much in Winters. What was in them was badly shaken up, but the buildings held together as a rule.

"On the Hotel Devilbiss a brick chimney was broken off close to the roof by the shock of the 19th and twisted halfway around. It was not broken more than that, and a couple of men easily twisted it back again and mortared it well. Yesterday's shock simply resolved that chimney into loose bricks and powdered mortar.

"The loftiest structures seemed to those looking on to have suffered most, as their walls fell outwardly, but in the one-story buildings the greatest havoc occurred, for the walls collapsed. Some of the escapes from instant death were exceedingly narrow. "The bank of Winters is now deserted. Its walls are full of wide cracks, its front is bulged, and piles of bricks lie on the sidewalk. There is not a vestige of glass in the windows, and the stout beams which were placed beneath the doorways a day or two ago to uphold the badly strained building are all awry and look as if a quake of moderate caliber would cause them to snap. The bank will need to be entirely reconstructed, and \$5,000 will barely cover the loss."

1892. April 21; San José.

There was a very slight shock felt in San José about 9.43 o'clock yesterday morning. It was one of only a couple of seconds' duration, and many did not feel it (III?). The shock was a little more pronounced in San Francisco, and severe shocks were felt but no damage done at Grass Valley, Santa Rosa, Newcastle, El-mira, Centerville, Fresno, Fairfield, Yuba, Nicolaus, Stockton, Nevada City, St. Helena, Napa, Antioch, Spanishtown, Benicia, Chico, Oroville, Biggs, Gearytown, Gold Run, Red Bluff, Sonoma, Auburn, Willows, Placerville, Downieville, Orland, and Maxwell. There was another light shock here at 7.15 last evening. It was hardly perceptible. Shocks were also reported in the evening from San Rafael, Vacaville, Lodi, Benicia, and other places in the State, and also from as far east as Carson, Nev. The tremors seemed to be very light and no damage was reported.

1892. April 21; Sacramento.

There was another severe earthquake shock at 9.45 o'clock this morning, lasting twenty seconds. Buildings got a lively shaking and plastering fell from many ceilings.

Several old chimneys toppled over and much glassware was broken in the crockery stores. The State capitol building suffered. A large portion of one of the plaster statues over the portico, 150 feet from the ground, fell and struck 40 feet from the building. The gigantic building trembled violently and the occupants in the State offices were badly frightened, and there was a general exodus of clerks.

It was discovered that a crack was made in the ceiling, extending from one end of the building to the other and going through the office of the superintendent of public instruction into the assembly chamber. The beautiful ceiling of the latter, which is formed of stucco work tipped with gold, was rent in places, as were also the Corinthian columns supporting the gallery. Books were thrown from the shelves and general disorder reigned.

The public schools were dismissed. All the pupils got out without creating a panic. At the city prison the greatest excitement prevailed. A number of police officers rushed into the street, expecting the collapse of the old building. Jailer John McManus stood at his post, with key in hand, prepared to turn loose the prisoners in case the building showed signs of collapsing.

1892. April 21; Dixon.

At 9.40 this morning the people of Dixon were warned of the approach of another earthquake, and the streets were soon filled with people rushing out of buildings in search of a place of safety. Small shocks continued at intervals all day, and to-night the houses are nearly all deserted and people are walking the streets.

The brick buildings are still standing, but every shock cracks them worse, and people expect them to fall down. The frame buildings are receiving so much shaking that many of the occupants have fled to the country for safety.

In the country things are getting to be in a frightful condition. Hardly a farmhouse has escaped injury, and many of them have been moved off their foundations. Most of the occupants have put up tents out in the fields. Reports of damage coming in to-day place the losses much higher than at first estimated, and it is now considered that \$100,000 will not cover the loss.

1892. April 21.

Santa Rosa received a severe earthquake shock at 9.40 a. m. to-day. The vibrations were from east to west, and lasted fully fifteen seconds. A deep rumbling sound was heard just before the first movement was felt. There were five vibrations, increasing in intensity to the last, which cracked many brick buildings and precipitated a good deal of plaster to the floor (VII). In two places brick walls were slightly bulged out, iron columns moved, and in some parts of the town chimneys were wrecked.

Many think that the shocks of to-day were much severer than were the shocks of Tuesday morning. The rumble of the earthquake was preceded by perfect stillness in the atmosphere.

The court-house was slightly damaged and everybody in it more or less frightened.

1892. April 21; Suisun.

Two severe shocks and one or two slight ones were experienced here to-day. The first heavy shock occurred about 9.40 a. m. and the next at 7.15 p. m. Although not so severe as that of Tuesday morning, they have terrified the people. All the stores were closed at 7.30 o'clock in the evening. Plaster was torn from many buildings, window panes were broken, clocks stopped, and many chimneys thrown down (VII).

1892. April 21; Madison.

The town was again shaken by the heaviest shock that has been felt, at 9.48 this morning. The total damage is about \$10,000.

1892. April 21.

Special cables to the New York *Herald* from Santiago, Chile, under date of April 21, say that during the past week details were received of severe and light earthquake shocks at Taltaval, Serena, and several coast towns.

1892. April 21; Yuba City.

At 9.43 o'clock this morning an earthquake occurred here, but it was not quite so heavy as that of Tuesday. Several clocks were stopped, but no damage occurred (V).

1892. April 21; Nicolaus.

An earthquake occurred here at 9.48 o'clock. The vibration was northeast to southwest. Its duration was twenty seconds.

1892. April 21; Newcastle.

There was a slight earthquake shock here about 5 o'clock this morning and another at 9.43 o'clock. No damage was reported.

1892. April 21; St. Helena.

A very perceptible earthquake occurred here at 9.40 o'clock this morning, sending the people into the streets (V) and stopping clocks. No damage was done.

1892. April 21; Bonita Point Lighthouse; 9:43 a. m.

(Light); 10 p. m. (light). Roe Island Lighthouse, not so severe as the shock of April 19. The vibration lasted 1m. 10s. N. W. to S. E., and was followed by a second shock 20 sec. later. A later report says, April 21, 7h. 16m. p. m. (railroad time): a shock lasting 35 sec., clock stopped, etc. (VI?). Lime Point Lighthouse, 9h. 53m. a. m. (clock regulated by time-ball in S. F.), duration about 2 seconds. Angel Island Lighthouse, 9h. 50m. a. m. (local time). (Ms. kindly furnished by U. S. Lighthouse Board, through U. S. Geological Survey.)

1892. April 21; Fairfield.

The principal damage by the earthquake in this vicinity is the almost total wreck of the Fairfield M. E. Church, a brick building 40 by 60, built in 1861, at a cost of \$10,000. The belfry is demolished, the walls cracked and sprung, and will have to be taken down. Many chimneys fell and considerable plastering was thrown down. Several houses were badly injured.

1892. April 21; Red Bluff.

Two perceptible earthquake shocks were felt here this morning. The first was very slight and occurred about 8.10 o'clock. The second stopped several clocks at 9.45 o'clock (V).

1892. April 21; Willows.

Another heavy earthquake was felt here at 9.43 o'clock to-day.

1892. April 21; Orland.

Another slight earthquake was felt here at 10.45 o'clock this morning. The vibrations were northeast and southwest. It was of eight seconds' duration.

1892. April 21; Esparto.

Another shock occurred here at 7 o'clock p. m. Five thousand dollars will cover the total loss.

1892. April 21; Dixon.

At 7.20 o'clock p. m. another sharp shock, but not as hard as the one in the morning. There were several more tremors during the night, but no further damage done.

1892. April 21; Woodland.

Dunnigan, Blacks, and Yolo, all experienced slight shocks in the night, but no further damage is reported.

1892. April 21; Madison.

Slight shocks of earthquake were felt here at 7 o'clock p. m. The total loss here is estimated at \$5,000.

1892. April 22; Esparto; 2h. a. m.

A tremor.

1892. April 22; Madison; 2 a. m.

A slight shock.

1892. April 23; Roe Island Lighthouse.

Shocks at 3 a. m. E. to W. (tremor), 4.53 a. m., N. to S., 5.40 a. m., N. W. to S. E.

1892. April 23; Carson City; 5:30 p. m.

S. W. and N. E. (II).—C. W. F.

1892. April 29; Grass Valley; 4h. 10m. p. m.

An earthquake shock lasting ten seconds. No damage.

1892. April 29; Marysville; 4h. 6m. p. m.

A slight shock.

1892. April 29; Vacaville; 4h. 7m. p. m.

A sharp shock. No damage.

1892. April 29; Woodland; 4h. 10m. p. m.

A shock. The vibrations seemed to be north and south. No damage.

1892. April 29; Davisville.

At 4.11 o'clock another shock was felt here, although slight. No damage.

1892. April 29; Carson City; 4:08 p. m.

Very short, S. E. and N. W. (III).—C. W. F.

1892. April 29; Roe Island Lighthouse; 4:04 p. m.

Three shocks.

1892. April 29; Petaluma; 4h. 5m. p. m.

Quite a sharp shock was felt. The vibrations were east to west.

1892. April 29; Winters; 4h. 10m. p. m.

A shock. No damage. The shock lasted about five seconds.

1892. April 29; Santa Rosa; 4h. 10m. p. m.

A very distinct shock. The vibrations were from east to west and were of about eight seconds' duration.

1892. April 29; San Rafael; 4h. 10m. p. m.

A slight shock.

1892. April 29; Napa; 4h. 10m. p. m.

A short, sharp shock. The vibrations were from north to south. No damage.

1892. April 29; Fairfield; 4:10 p. m.

A heavy shock. No damage.

1892. April 29; Benicia; 4h. 10m. p. m.

A very severe shock. No damage.

1892. April 29; Stockton; 4:08 p. m.

A light shock, lasting twenty seconds.

1892. April 29; Haywards.

Two sharp shocks were felt here this afternoon, one occurring at about 4, and the other at 7.35 o'clock. The vibrations were from east to west in each case.

1892. April 29; San Leandro; 7h. 30m. p. m.

A sharp earthquake shock. It was a "twister," seeming to come from all points of the compass. The duration was about 1½ seconds.

1892. April 29; San Francisco; 4h. 10m. p. m.

A slight earthquake shock was felt, but no damage was done.

1892. San Francisco; 4h. 7m. p. m.

Light vibration; duration 1 sec.—T. T.

Fort Point Lighthouse, 4h. 7m. 30s. Very light shock; duration 1½ sec.

1892. May 11; Mount Hamilton; 9:48:32 p. m.

The duplex seismograph shows a displacement of the pen of 1.5 mm. in a northeast and southwest direction, and of 2.5 mm. in northwest and southeast direction, the time recorded by Prof. Holden, 9.48.32 p. m., P. S. T. Intensity = IV on the Rossi-Forel scale.

1892. May 21; Virginia City.

8 p. m., 10 p. m.

1892. May 28; Ontario.

There were two light shocks this morning. The first was at 3.15 o'clock and the second five minutes later. They were heavy enough to stop clocks. The course of the wave was northeast and southwest (VI).

1892. May 28; Santa Ana.

Earthquake shocks were felt here between 2 and 3 o'clock this morning. The first shock was quite heavy and lasted a minute or more.

1892. May 28; San Bernardino.

Two shocks of earthquake were felt here this morning at 3.15 and 3.20 o'clock. The first shock was very heavy, throwing down dishes and stopping clocks (VI). The second was much lighter. The vibrations were from east to west.

1892. May 28; Carson City.

Tremor recorded on seismometer.—C. W. F.

1892. June 9; Independence.

Mr. C. Mulholland reports a disturbance at 3.40 p. m. A rumbling sound was almost immediately followed by the shock, which had an undulatory movement from north to south. The building shook so as to make all loose things rattle, but no harm was done (IV). No damage. Only one shock was felt and that was of short duration, probably lasting not longer than two seconds.

1892. June 14; Riverside.

The heaviest earthquake felt here in many months occurred this morning at 5.30 o'clock. No damage.

1892. June 14; Santa Ana.

A shock lasting nearly thirty seconds. The vibrations were from east to west.

1892. June 14; Pomona; 5h. 25m. a. m.

A sharp earthquake. It lasted a few seconds.

1892. June 14; San Diego; 5:17 a. m.

Quite perceptible shock in this city and county. No damage.

1892. June 14; San Bernardino; 5h. 20m. a. m.

A slight earthquake, lasting at least twenty seconds. It was not severe, but the shaking lasted unusually long. The vibrations were from northwest to southeast.

1892. June 22; Hollister.

Two slight shocks last night.

1892. June 22.

Messrs. Rose and Rikert, in the Santa Clara Valley, near Alamo, Lower California, last Friday, noticed two peaks four miles to the north alternately spouting smoke and flames at short intervals. The eruption was accompanied by rumbling sounds and an occasional quiver of the ground. Though frightened, they stopped long enough to satisfy themselves that two veritable volcanoes had opened. Later travelers report the volcanoes real, but not so active as at first. The region is undoubtedly volcanic, sulphur springs being in the vicinity.

1892. June 26; San Francisco; 5h. 43m. a. m.

N. E. and S. W.; duration 4½ seconds.—T. T.

1892. July 6; Carson City; 7 a. m.

E. and W. tremor.—C. W. F.

1892. July 9.

San Francisco was shaken this morning by a remarkable series of explosions. The giant powder works at Highland Station, fully fifteen miles away, across the bay, exploded, completely wiping out the works, killing five men, wounding more than a score, and causing the effect in this city and Oakland of a severe earthquake. Nothing like the effects of the great shock has ever been known here. The shock caused a rush of air like the first breath of a tornado. Then came a series of shocks attended by a dull roar, like the discharge of heavy artillery at sea. Hundreds rushed out of tall buildings and hotels, pale with fear. Broken glass fell all about them. Scores of heavy plate-glass show windows came crashing into the streets.

The heavy earthquake several months ago was not so terrifying a shock as this. The new high office buildings swayed perceptibly. In old structures plaster fell from the walls and all movable articles on shelves came tumbling to the ground (VII). Seven minutes after the first shock came another, even more severe, which shattered windows all over town, rocked buildings, blew in skylights, broke plate glass on Montgomery Avenue, Montgomery Street, Kearney Street, and other thoroughfares, and caused people to rush into the streets. The consternation was still at its height when two more shocks followed, little less severe than the terrific one which had just been felt. Glass rat-

tled into streets all over the city, and not a few buildings came near collapsing.

The men in the tower of the fire-alarm station were sure that structure was going to go down. At the Palace Hotel there was great fear among the guests, and all over the city there was alarm.

The motion was entirely unlike that of earthquakes. Investigation showed that the giant powder works at Highland Station had exploded, and this had involved the Judson Chemical Works near by. At this writing three white men are known to be killed, two Chinese are dead, and about twenty Chinese are badly wounded. The explosions started in a nitro-glycerine tank about fifty yards from all the other buildings at the works.

What caused this will never be known, for the men who were in the building were blown into fragments. All that saved the 150 men who were at work in the outer buildings was the interval between the original explosion and the next. This was six minutes, and in this time all the hands, white and Chinese, made a rush over the neighboring hill to put that elevation between themselves and the awful death that they knew was so near at hand.

The force of the first explosion was heavy, but it was slight compared with the others. First, the powder-mixing house, about a rod from the nitro-glycerine house, went up in a sheet of flame and with a roar that could be heard clear across the bay. A moment later a storehouse followed, also about one rod distant. The houses all caught from the flames, but full 100 rods farther, over a little hill, were three great magazines of giant powder, black powder and dynamite, all of which were exploded by the concussion. The first three explosions had been heavy, but they were dwarfed by the terrific effect of the blowing up of the first magazine, which contained 350 tons of giant powder. This enormous amount of explosive was in a brick house about 30 by 140 feet, and 20 feet high, lying close to the bank, near the water's edge. In quick succession followed the blowing up of a magazine containing 150 tons of black powder and another containing an unknown amount of dynamite. These terrific explosions caused so great a shock that a large pile of sulphur on a neighboring wharf was set on fire and a vessel that was unloading it was allowed to drift away to save it from the same fate. The force of the explosion wrecked the strong wooden buildings of the Judson Chemical Works a quarter of a mile away. The walls fell in, and the chemicals began to blaze fiercely. Within one hour the large plant of both works was totally destroyed.

The only building of the powder works remaining is a large magazine of gun-cotton which the firemen are trying to save. It

stands some distance from the scene of the explosion. It will probably not explode. No greater scene of desolation could be conceived than that presented after the explosion. Everything belonging to the buildings was smashed into matchwood.

Over the little hill were the cottages of workmen and residences of Judson and his superintendent. Here most curious freaks were seen. One whole side of Judson's house was ripped off, and the plastering was all torn off and covered his fine furniture. In the other house the main stairway was twisted completely around, and one chimney had also been whirled completely about, the top falling off outside. All the little cottages were wrecked so badly that they can never be repaired. All that can be done is to tear them down. The escape of the inmates was miraculous. Only one boy was seriously hurt. He had his arm broken.

One of the largest windows broken in San Francisco was that on the south side of the First National Bank building, corner of Bush and Sansome streets. The Baldwin Hotel was damaged, and windows on several floors were smashed to pieces. The two panes of plate glass in the windows of the San Francisco clearing house, at 211 Sansome Street, were the largest in the city. The one on the south side was shattered into small pieces, and the pane on the north side was uninjured. They were seven-sixteenths of an inch thick, and each cost \$600. The glass in most of the windows of the American sugar refinery was broken.

1892. July 9; Berkeley.

Recorded on duplex instrument.—Professor Soulé.

1892. July 9; Alameda.

The explosion of the giant-powder works made a record on my seismograph, the maximum displacement of the pen in a north and south direction being 4 mm. and in an east and west direction 4 mm. (C. D. Perrine.)

1892. July 9; East Oakland.

Mr. F. G. Blinn reports that his seismograph was not in working order, owing to the fact that the soil is adobe, and as it had not been irrigated for some time the working of the soil caused the pen to creak so much that any attempt at records was abandoned. After the powder works explosion the pen was found off the plate on the east side making a nearly straight line, and this would indicate a motion of the ground to the west. (The powder works were about northwest.) A pipe lying on a shelf in the observatory was thrown on the floor to the east, thus confirming the motion of the seismograph. There was an item in the San Francisco *Evening Bulletin* saying that the sealing schooner Emma and Louise, then 150 miles off shore, felt the shock heavily, and it was thought she had struck a rock.

1892. July 9; Oakland.

Mr. Charles Burkhalter reports that the seismograph at the Chabot Observatory showed a V-shaped mark about 4 mm. in height.

1892. July 16; Mount Hamilton.

Prof. Holden reports a shock at 12.6.34 ± p. m. P. S. T. Intensity = III on the Rossi-Forel scale. The duplex seismograph shows a small mark about 1.5 mm. north and south by 1 mm. east and west.

1892. July 22; Carson City; 6:50 a. m.

N. W. and S. E. tremor.—C. W. F.

1892. July 24; Colton.

The San Francisco *Examiner* reports a shock of earthquake at this point at 6 a. m.

1892. July 26; Napa.

"A heavy shock" at 2.10 a. m. Vibrations north to south. No damage.

1892. July 26; Petaluma.

"Quite a lively shock." Vibrations east to west.

1892. July 26; San Francisco.

A slight shock 2h. 8m. a. m. Duration 2 sec.—T. T.

1892. July 26; Mount Hamilton.

The duplex seismograph shows a light shock, the displacement of the pen in a north and south direction being 1 mm. and in an east and west direction 2 mm. The shock was not felt by any one.

1892. July 26; Berkeley.

Slight record.—Professor Soulé.

1892. July 26; Fort Point Lighthouse; 2:04 a. m.

Moderate, lasting 10 sec. A very light shock at 2.59 a. m.

1892. August 1 or 2; Mount Hamilton.

A shock occurred August 1 or 2 and was found recorded on both seismographs, not being of sufficient intensity to start the Ewing instrument, and no one felt it. Displacement of duplex pen northwest and southeast, 4 mm. Almost a straight line.

1892. August 2 or 3; Mount Hamilton.

Another slight shock was found recorded by the duplex, but was not felt by any one here. Displacement of pen east and west, 3 mm. Almost a straight line.

1892. August 5, 6; Mount Hamilton.

A slight shock was found registered by the duplex seismograph, but felt by no one. Displacement of pen north and south, 2 mm. East and west, 1 mm.

1892. August 8-9; Mount Hamilton.

A slight shock was found registered by the duplex instrument, but unnoticed by any one. Displacement of pen north and south, 1.5 mm.; east and west, 2.5 mm.

1892. August 18; Mount Hamilton.

Prof. Holden reports a shock estimated at intensity (V) of the R. F. scale as occurring at 8.8.27 p. m. \pm 3s. or 4s. P. S. T. 8.8.23 p. m. standard Pacific time: a diffused shock extending three or four seconds; fairly heavy. Time refers to about middle of shock. (E. E. Barnard.)

1892. August 24; Mount Hamilton.

12.22.14 P. S. T. Decided shock of one or one and one-half seconds' duration. Examining *Mars* at the time. Image of the planet jumped through five or six seconds. The shock consisted of three or four jerks or jars. The motion seemed to be vertical in the telescope. The shock was felt outside of the telescopic vibration. (E. E. Barnard.)

1892. August 25; Mount Hamilton.

The duplex seismograph shows a slight shock, the displacement of the pen being 2 mm. in a north and south direction and 1.5 mm. in an east and west direction.

1892. August 28.

A volcanic eruption of great magnitude took place on one of the Aleutian Islands, Alaska, on August 28. Black Peak, a mountain of great height between Chignik canneryes on the Aleutian Islands, and Oonangashik, a station of the Alaska Commercial Company, is supposed to be the volcano in action.

A letter received from Olef M. Olson, sailing master of the schooner Clara, of Sitka, formerly the Ethel, of San Diego, dated from Sand Point, Alaska, September 8, gives the following points:

"On Sunday, August 28, the eruption took place. The Clara was lying at anchor in Chignik Bay abreast of the canneryes, and observed a beautiful cloud. It first made its appearance at 4 o'clock in the morning, rose straight in the air from behind the mountains in the southwest until at an angle of about 35°, when it lost its beautiful color, which was blue, and seemed to burst lightly. It remained until after noon, when it got perfectly black. The barometer was all the time steady at 30 inches. About 11 o'clock the earth was shaken heavily. Accompanying the shock were thunder and lightning, which continued all that

day and all the evening. Monday morning when I came on deck my mouth and nose were filled with some stuff that fell heavy and thick about us. The air itself was full of sulphur smoke, which even permeated the cabin, and the decks were covered with fully 2 inches of black sand. Nothing could be cooked because of it. It penetrated everywhere. At noon when the stuff was getting lighter we could see the cannery. We went ashore and found everything one color, black. The schooner Nellie, of Sand Point, coming from Vessnessensky, reported that the store-keeper, N. Zwain, had seen on the day of the eruption, rocks on fire thrown in the air at an angle of 20° in the direction of Portage Bay, which seemed to be a mass of fire and flames. The Alaska Commercial Company's steamer St. Paul experienced the same shower of sand 250 miles off shore that day. On Monday afternoon some stuff, different from what fell on us the night before, came down from the direction of the mountain known as Black Peak, between Chignik and Oonangashik. It appeared more like burned paper. The following day, Tuesday, another light shower fell the whole afternoon. Chignik bay itself had a muddy appearance and all the high grass was knocked down by the heavy sand. It will take some time for the glaciers to get their natural color. The fall was heaviest on Monday morning between 2 and 4 o'clock."

1892. August 30; Tybo (Nev.), 9 p. m.

"Distinct."—C. W. F.

1892. August 31; Independence.

Mr. C. Mulholland reports a shock occurring at 5 p. m. It was quite sharp and was preceded, three or four seconds, by a sound like distant thunder. There appeared to be three or four sharp vibrations coming from the south. No reports of damage.

1892. August 28.

The origin of the immense cloud of volcanic dust which was reported by Capt. Erskine as having passed over the steamer St. Paul on her last trip up to Oonalaska, and which he estimated to be more than 100 miles in extent, has been definitely ascertained. The sea otter hunting schooner Everett Hayes arrived here last week from the Shumagin Islands, and from her owner, I. J. Applegate, the following particulars of the eruption of a new volcano have been obtained:

On Sunday, August 28, the Hayes put into Ivanef Bay at the extreme western end of the Alaskan peninsula, and anchored. The position of the schooner was in lat. 55° 52' north and long. 159° 20' west. The weather at the time of anchoring was calm and clear. About midnight of the 27th the crew of the schooner were aroused by a subdued rumbling noise, which sounded not unlike

the steady breaking of surf on the beach. Knowing that such a noise would hardly be heard in the inclosed bay, the captain and Mr. Applegate went on deck to ascertain, if possible, the cause of the disturbance. The night was then calm and clear and not a thing could be seen, so that the two watchers returned to their bunks with the mysterious noise still unexplained.

About 2 a. m. the mate went on deck and shortly afterward reported seeing what appeared to be a small black cloud low down in the northwestern sky. The rumbling noise now gradually increased in volume and soon the whole sky was filled with dense volumes of smoke. Before daylight the crew of the schooner saw a vast column of smoke suddenly shoot straight up to a distance of a mile into the clear atmosphere and then slowly expand in the form of an immense cauliflower from 10 to 12 miles in diameter. From the lower edges and periphery of this black cloud blinding flashes of lightning shot downward toward the base of the column, and the air was filled with almost continuous and deafening detonations as if of thunder. The display was magnificent beyond description. It lasted until daylight. Feeling that the vicinity was anything but pleasant or safe the schooner got under way as early as possible Monday morning, and made her way out into the open waters of the Pacific. A brisk northerly wind swept the smoke cloud clear of the schooner, but the country to the southward must have been covered for miles with ashes and cinders, which fell like a heavy rain from the cloud. At Metrofem, a small native settlement 80 or 90 miles away, the inhabitants witnessed the eruption and distinctly heard reverberations of the thunder, and at all the islands lying to the southward of the peninsula quantities of dust and cinders fell during the greater part of three days.

The exact locality and appearance of the new volcano could not be obtained for the reason that it is inland some 30 miles, as estimated by Mr. Applegate, and hidden from view by the higher mountains which border the sea. It must, however, be of considerable extent, as there can be no doubt now that the rain of volcanic dust which fell on the decks of the St. Paul during five hours of August 28 came from the new volcano. In connection with this upheaval it is of interest to recall the fact previously noted by the *Chronicle* correspondent of the unusual activity of all the volcanoes situated along this part of the Aleutian Islands during this season.

On September 23, while the revenue-cutter Rush was cruising in the vicinity of Akutan Island, the volcano situated thereon suddenly opened up its hidden batteries, and blast after blast of dark purple smoke shot upwards from the crater to a distance of nearly 1,000 feet, accompanied by a rumbling noise like distant thunder. At the same instant, as was subsequently ascertained,

a distinct earthquake shock—something very unusual in this region—was felt at Oonalaska, 30 miles away.

1892. September 8; Petaluma; 4h. 45m. a. m.

A light shock. The vibration seemed to be from east to west. Also felt at Napa.

1892. September 13; San José.

A shock.—Cal. S. W. Service *Bulletin*.

1892. September 25; Stockton.

A shock.—Cal. S. W. Service *Bulletin*.

1892. September 25; Mount Hamilton.

Prof. Holden reports a shock of slow period and intensity = III of the R. F. scale, as occurring at 2.10.43 p. m., P. S. T. The duplex seismograph shows a displacement of the pen of 9 mm. in north-northeast and south-southwest direction, with a displacement of the pen at right angles to this of 3 mm.

1892. September 25; Mills College.

Prof. Keep sends a tracing of the shock occurring at 2.10 p. m. in which the greatest displacement is in a north-northeast and south-southwest direction, and appears to be about 11.5 mm., and at right angles to this the displacement is only 3 mm.

1892. September 25; Alameda.

A shock of earthquake estimated at about (V) of the R. F. scale occurred at 2.11 p. m., the chandeliers swaying for several minutes. The duplex seismograph gives a record in which the displacement of the pen in a northwest and southeast direction measures 77 mm., which is probably exaggerated, although the greatest disturbance was noticed to be in this direction. The displacement of the pen in the northeast and southwest direction is 20 mm. (C. D. Perrine.)

1892. September 27; Napa City.

A shock.—Cal. S. W. Service *Bulletin*.

1892. October 26; San Bernardino; 7h. 5m. a. m.

A slight shock. The vibration was from north to south.

1892. October 30; Mount Hamilton; 12:17:12 a. m.

Southeast to northwest; two slight shocks two seconds apart. Intensity = III. (W. W. Campbell.) The duplex seismograph gives a record of about 2 mm. in both the north and south and east and west directions.

1892. October 30; Independence.

Mr. C. Mulholland reports a shock occurring at 11.53 a. m. The shock was quite heavy and appeared to come from the Sierras

about 6 miles west of the town, but the greatest motion appeared to be vertical or nearly so. Only one shock was felt. The earth rumbling was not very noticeable owing to the rattling of the building. No damage.

1892. November 6; Austin (Nev.).

"Light," E. to W.—C. W. F.

1892. November 12; Niles (Cal.).

1.56 a. m.; 13th, 4.45 a. m., 11.20 p. m., 11.23 p. m.

1892. November 13; 4:45 a. m.

Santa Cruz Lighthouse.

1892. November 13; Mount Hamilton.

Prof. Holden reports two shocks of earthquake close together, of intensity (V) of the R. F. scale.

Time of the second shock 4.45.14 a. m. The duplex seismograph gives a condensed tracing 4.5 mm. by 3.5 mm. The plate is not orientated. Mr. Townley, who was photographing in the Crocker dome at the time of the shock, noted the time (of the first shock?) as 4.44.41, P. S. T.

1892. November 13; Berkeley.

"The earthquake of Sunday was hardly felt here. Very small vibration. Record on duplex and Ewing, but vibration not strong enough to start the seismograph." (A. O. Leuschner.)

1892. November 13; Mills College.

Prof. Keep sends a tracing of the earthquake which occurred at 4.46 a. m., showing a displacement of the pen of 12 mm. in a northeast and southwest direction, and 8 mm. in a northwest and southeast direction.

1892. November 13; Alameda.

A slight shock occurred at 4.48 a. m., giving a tracing on the duplex seismograph, which begins with a displacement of the pen of about 5 mm. toward the southeast and ends with a number of tremors covering an area 2 mm. in a north and south direction by 1.5 mm. in an east and west direction. (C. D. Perrine.)

1892. November 13; Petaluma; about 4h. 45m. a. m.

A lively shock. The vibrations were from north to south. Also felt at Napa.

1892. November 13; Gilroy; 4h. 45m. a. m.

A very heavy shock. It was of several seconds' duration. Clocks were stopped and small articles thrown down. No damage was done to buildings (VI).

1892. November 13; Hollister; 4h. 45m. a. m.

An unusually severe shock. The heavy shock was followed by three of less severity. Aside from the falling of plaster no material damage was done (VI?, VII?).

1892. November 13; Salinas.

At about 4.30 o'clock this morning a heavy earthquake was felt here, doing considerable damage to large window lights, glassware and crockery. The vibrations were from northeast to southwest. They lasted fully forty seconds (VI).

1892. November 13; Monterey.

An extremely lengthy and heavy shock was felt in this city at 4.45 o'clock this morning. The vibration was north and south. It rattled large buildings as if they were chips, shaking crockery and glassware off the shelves, cracking chimneys and playing havoc in general. The oldest citizens say that they have never experienced such a heavy tremor as they felt this morning, the shock being of ten seconds' duration and followed by smaller ones (VII).

1892. November 13; San Rafael; 4h. 46m. a. m.

A shock lasting eleven seconds. The movement was from north to south.

1892. November 13; San Francisco; 4h. 45m. a. m.

Light shock, E. and W., duration 3s.—T. T.

1892. November 13; San José; 4:46 a. m.

Lasting 6 to 8 seconds.

1892. November 24; San Francisco; Oh. 10m. a. m.

Light shock, duration 2 sec.—T. T.

1892. November 24; Niles; 12:07 a. m.**1892. Berkeley; 7h. 9 $\frac{1}{2}$ m. p. m.**

Record on Ewing instrument. Clock started.—Professor Soulé.

1892. November 25; Austin (Nev.).

E. to W.—C. W. F.

EARTHQUAKES ON THE PACIFIC COAST, 1893.

1893. January 13; Mount Hamilton.

Prof. Holden reports the shock at 1.2.22 \pm 5s. a. m. of intensity (V), Rossi-Forel scale.

Mr. Colton reports the time as 1.2.25 a. m.

Mr. Townley reports the time as 1.2.16 a. m.

The duplex seismograph gives a complicated tracing, 5 mm. by 3 mm.

The Ewing instrument shows a motion east and west in the horizontal, but none in either the north or south or vertical directions. The greatest amplitude of the Ewing *record* is 3 mm., the shock lasting fifteen to twenty seconds. Mr. Colton's record shows that the first motion of the earth was to the east.

1893. January 24; Winters; 9h. 40m. p. m.

1893. January 25; Winters; about 1 a. m.

A shock last night at 9.40 and another about 1 this morning. Both were light, but pronounced enough to scare the timid.

1893. February 15; Berkeley; 3h. 15m. a. m.

Slight records.—Professor Soulé.

1893. February 16; Berkeley.

Slight records.—Professor Soulé.

1893. February 16; Sydney, Washington.

II.—P.

1893. February 21; Fairfield.

A heavy shock at 8.15 p. m. to-day.

1893. February 21; Suisun.

A sharp shock at 8.16 o'clock this evening.

1893. February 21; Dixon.

Quite a severe shock at 8.20 o'clock this evening.

1893. February 22.

It was felt at San Rafael at 8.15 (a. m.? p. m.?).—Professor Soulé.

1893. March 3; Grass Valley.

"A perceptible shock" at 6.15 a. m.

1893. March 3; Carson City; 12:05 a. m. and 6:40 a. m.

E. and W.—C. W. F.

1893. March 3; Nevada City; 6:40 a. m.

Iowa Hill, 6.38 a. m.

1893. March 6; Umatilla, Oregon.

A succession of shocks were felt here to-night. One of the walls of a large stone building was thrown down by the force of the shock (VII?, VIII?).

1893. March 12 and 13; Berkeley.

Slight records.—Professor Soulé.

1893. March 18; Shelter Cove, Cal.

Thirteen shocks, N. and S.—Cal. S. W. Service *Bulletin*.

1893. March 27; Santa Rosa.

A slight shock at 11.30 o'clock to-night. The vibration was from east to west and the shock was of only a few seconds' duration. No damage.

1893. March 30; Independence and Lone Pine, Inyo County.

Mr. C. Mulholland reports: "On the evening of last Thursday, March 30, at 10.30 o'clock, an earthquake occurred. The center of disturbance appeared to be about 9 miles north from the south end of Owens Lake. At that point there is a strip of land 2 miles wide between the lake and the base of the Sierra Nevada on the west. But one shock was felt; this was very sharp; the earth motion may be likened to the result of a blow struck upon a plank by a sledge. At Lone Pine, 30 miles farther north, the shock was felt about the same time; the vibration was not so sharp, but more undulatory. No damage."—Carson, March 30, during the night, N. E. and S. W., tremor, from seismometer.—C. W. F.

1893. March 31; Vacaville.

A sharp shock at 2.30 this morning. It lasted several seconds, and its direction was from north to south.

1893. April 4; Mojave.

At 11.40 a. m. to-day this place was visited by four distinct shocks of earthquake. Buildings were rocked for several seconds, creating considerable fright (VII?). At Saugus, 70 miles south, chimneys were knocked down and dishes and other household furnishings were broken (VIII?). The impression is that the shock came from the northeast.

1893. April 4; San Bernardino; 11h. 40m. a. m.

A heavy earthquake, moving in a southeasterly direction. No damage.

1893. April 4; Santa Ana; 11h. 45m. a. m.

A slight earthquake was felt, the movement seeming to be from west to east. The vibrations were so slight, however, that many people were not aware there had been any disturbance of the earth's surface (III).

1893. April 4; Los Angeles.

At 11.48 this morning there was a slight earthquake of short duration. The movement was from west to east. In Observer Franklin's office the barometers were well shaken, and continued to oscillate perceptibly for two minutes at least. It lasted about eighteen seconds (III?).

1893. April 4; San Diego; 11h. 42m. a. m.

A slight shock. It was felt only in the upper stories. It shook the barometer at the signal office (III?).

1893. April 4; Duarte; 11:30 a. m.

Light shock, E. and W.—Cal. S. W. Service *Bulletin*.

1893. April 4; Ventura; 11:44 a. m.

"Heavy."—*Ibid.*

1893. April 4; Nordhoff; 11:30 a. m.

"Heavy."—*Ibid.*

1893. April 8; Los Angeles.

Alarming reports of seismic disturbances have just been received from the oil region of Newhall, 35 miles from this city.

Dating from last Tuesday, the day on which Los Angeles experienced a slight shake, there has been a terrifying series of temblors, accompanied by subterranean explosions. These disturbances have been frequent, and have been accompanied by landslides from the mountains of an alarming and dangerous description. A letter dated from Pico Canyon, about 8 miles southwest from Newhall, reads substantially as follows (and refers to the shock of Tuesday, April 4).

"I was driving this morning when my horse became frightened without apparent cause, and there came a rumbling sound which grew terrifying. I looked up and saw an awful sight. Landslides from every peak in sight came tumbling down with huge boulders. The mountains appeared as if myriads of volcanoes had burst forth. When I got to the long bridge I saw Mr. Thomas standing dazed, holding to the railing, and others came running across the bridge. The earth opened in a number of places and the scene was indescribable. Men cried, prayed and swore. When I reached my house I found everything upset. Pictures, dishes, and everything breakable were smashed, and two stoves were broken all to pieces. All the afternoon lighter shocks continued, and also through the night" (VII).

Another letter dated on Friday, April 7, says:

"On Wednesday night, just as I had gone to bed, 'Crash!' came another great shock. All night long they recurred, keeping us up until morning; and all day Thursday they continued, each preceded by a heavy subterranean explosion. The house the foreman lived in was demolished this time. Last night was less exciting, and at 3 o'clock this (Friday) morning we had another, which was fully as terrifying as the first. The shocks were worse in the canyon here than elsewhere, but at Newhall and all around this part of the county they have been terrifying" (VII, VIII).

1893. April 9; Los Angeles.

The San Fernando range of mountains, where the greater disturbance took place during the week, were pretty generally shaken up every day, beginning with Tuesday. The last tremor, a

slight one, was felt in the canyon about 10 o'clock Sunday night. There were no shocks so severe as the first one, and they gradually lessened in force and frequency.

As far as can be learned the area of the temblors was not confined entirely to the San Fernando range, but dipped across the big Newhall ranch, past Saugus and over into the Castac and Piru mountains, north of Newhall. Strange as it may seem, although Newhall is only 8 miles from the Pico Canyon, where the shakes were more continuous than elsewhere, the people in that town did not feel many of them.

The greatest disturbance was in and around the oil wells of the Pacific coast and San Francisco companies at the head of Pico Canyon.

Mintryville is a little town with a schoolhouse, and is the residence of the superintendent of the oil companies. Scattered about are pretty little cottages, the homes of employés.

One who has not visited the peculiarly formed canyon can hardly have a clear conception of the consternation with which the earthquakes were received by the 130 people who live in this vicinity. Temblors that would, as these did, tilt up great oil tanks full of oil, detach immense boulders from the mountain sides weighing tons, and cause big surface fissures in the ground in various places, are not calculated to make people rest well at night, and when these disturbances continue at irregular intervals for five days it is a wonder that the women and children in the canyon bore the ordeal as bravely as they did.

Mr. Mintry gave his recollection of the big earthquake of Tuesday (April 4):

"It was a few minutes after 12 o'clock. The men had nearly all left the derricks. Suddenly there was a peculiar swaying of the ground and an explosion which I can hardly describe. It was heavier than any blast I ever heard. I was on horseback, and the horse was frightened very badly. At first I thought of a boiler, but looking along the San Fernando range, as far as I could see east and west, there was a blinding cloud of dust. It rose directly up from the top of the range and was thick. All around me the dust rose from the hills in the near vicinity and earth and boulders came tumbling down. The shock lasted between ten and fifteen seconds. I looked across the valley and saw the same thing in the Castac Hills. That shock was the worst and it was accompanied by a rumbling sound. The shocks since that time have been smaller ones. They have not affected the flow of oil. There was not the slightest disturbance in any of the wells. I have been here for nineteen years as superintendent of the oil wells, and this is the first time there has been an earthquake in this vicinity."

At the head of the canyon and at Mintryville, which is nearly 2 miles below, the first shock played havoc with the crockery in nearly all the houses in both places, and a lot of milk pans full of milk, a quantity of eggs, and the stove and nearly every loose article in one house were thrown in a jumble on the floor and mixed up with the ashes (VII).

The schoolhouse had a large brick chimney, and after the shake there was not a whole brick left (VIII?). An immense stone came tumbling down a mountain side and landed in among the pipe lines and tanks below, smashing things generally.

Strange to say, not one of the many huge derricks, which are from 40 to 70 feet in height, was overturned, although they swayed in an alarming manner (VII).

The motion in all the shocks was a swaying motion, and the direction was from northwest to southeast. An old and strong adobe house on what is known as the middle Newhall ranch, northwest of Newhall, was shaken completely down by one of the temblors (VIII).

1893. April 6-8; Albuquerque, N. Mex.

The inhabitants of the river towns south of the city are much alarmed. During the past forty-eight hours the earth has frequently shaken. The depot at Las Lunas shook to such an extent early this morning that the agent fled in terror (VII). The Indians living in the valley are also much excited. No earth tremors have been felt here (*i. e.*, at Albuquerque).

1893. April 8; Albuquerque, N. Mex.

Las Lunas, Belin, and several other towns along the Rio Grande River are all in excitement over what appears to be a series of infantile earthquakes. Four shocks have been distinctly felt since Thursday (April). There was one this morning, attended by ominous rumbling underground and of three seconds' duration, during which time eight or ten vibrations were felt. Glass was broken, dishes rattled, and a few frame houses in the towns swayed as if shaken by a terrible windstorm (VI?, VII?).

1893. April 13; Hydesville.

A shock was felt here at 5 o'clock this morning. It was followed in fifteen minutes by another and severer shock, lasting fifteen seconds, and this was followed in fifteen minutes by another heavy shock. Four shocks between 3 and 6 a. m.

1893. April 13; Eureka.

A light shock was felt here this morning at 5.10. No damage. Cape Mendocino Lighthouse felt the shock of April 13, though there is no separate report of it.

1893. April 13; Humboldt Lighthouse; 5:12 a. m.

A severe shock lasting 10 or 12 seconds. Direction N. E. to S. W.
A second shock 3 or 4 minutes later.

1893. April 21; San Rafael; 11h. 15m. p. m.

A slight shock. The vibrations were from north to south.

1893. May 10; Duarte (Cal.).

A shock.

1893. May 18; Santa Barbara; 4h. 35m. p. m.

A distinct shock. Buildings shook so that the people in the second stories ran out (VI). No damage. The vibrations were from northwest to southeast.

1893. May 18; Point Conception Lighthouse; 4:30 p. m.

Duration 10 sec., followed immediately by a second shock, duration 3 sec. Angel Island Lighthouse 10.01 a. m. (local time), duration 2 sec. Point Fermin Lighthouse, 4.35 p. m. (standard time), duration 34 seconds. Moderate; light objects overthrown (VI?), N. W. to S. E.

1893. May 18; Berkeley; 9:45 a. m.

Slight record; also noticed by laborers on the grounds.—Professor Soulé.

1893. May 18; Satieoy; 4h. 36m. p. m.

Three distinct shocks, lasting for forty-three seconds, with vibrations from north to south, causing dishes to rattle and hanging lamps to swing to and fro (VI).

1893. May 18; San Pedro; 4h. 35m. p. m.

Two distinct shocks of about six seconds' duration, from north to south.

1893. May 18; Santa Ana.

The earthquake at 4.25 this afternoon was one of the hardest ever felt here, but no damage was done. A few people above the ground floors started for the streets, but it was a momentary fright only (VI).

1893. May 18; Lompoc.

A shock was felt here at 4 o'clock this afternoon. The vibrations seemed to be from east to west. No damage.

1893. May 18; Ventura; 4h. 35m. p. m.

A very distinct shock, lasting about fifteen seconds. The oscillation was east and west. Many people ran out of their houses (VI?, VII?).

1893. May 18; Oakland.

Yesterday morning at 10.03 o'clock two severe shocks of earthquake were felt in Oakland. The buildings on Broadway were shaken quite hard, and some of the people ran into the street (VI). (May 19).

1893. May 18; Carson, Nev.

The monthly review of the Nevada State Weather Service for May, 1893, reports a shock on May 18 at 2.55 p. m. Mr. C. Mulholland reports from Los Angeles under date of May 18, as follows: "It is now 4.30 p. m., and an earthquake has just strongly shaken the building. Furniture in the room vibrated so much as first to attract my attention. The motion appeared to be from west to east. There were several—four to six—short, jerky vibrations. No damage observable" (VI?).

1893. May 26; Mariposa.

A shock.

1893. June 1; Santa Barbara; about 4h. a. m.

Another earthquake, which lasted several seconds. It was considerably heavier than the one two weeks ago (VII?).

1893. June 1; Ventura; 3:50 a. m.

Nordhoff, 4 a. m., lasting 20 sec. Also shocks at 4.02 and 4.10 a. m., both lighter.

1893. June 6; San Francisco; 9h. 25m. a. m.

The shock was felt all over the city. Buildings shook, windows rattled, and men employed in down-town houses rushed out to see what it was all about.

The shock was felt very differently in different parts of the city. On Telegraph Hill and on Pacific Heights it was felt very much more than in the Mission and on lower ground.

Its motion was from east to west. In Oakland it was considered to be more than usually severe.

In the office of Prof. Davidson, in the Appraisers' building, a curious occurrence was noted. There were three men in the room. One was standing and facing west at the moment the shock came. The other two were sitting, one facing south, the other north. While the two men who were sitting felt the earthquake and thought it a severe one, the man standing did not feel it at all. The earth trembled only for two seconds.

1893. June 6; Alameda; 9h. 30m. a. m.

Quite a shock.

1893. June 18; Santa Rosa; about 5h. a. m.

A slight earthquake. The vibrations were quite distinct, but no damage was done.

1893. June 30; Vallejo; 5h. 30m. a. m.

Two pronounced shocks created considerable excitement for the few moments they lasted. The first shock was felt at 5.30 o'clock, and was closely followed by the second, which awakened people and was accompanied by a distinct rumbling noise (V?, VI?). The vibrations lasted about two minutes. No damage was done beyond the breaking of crockery.

The shock was quite noticeable on Mare Island.

1893. June 30; San Rafael; 5h. 35m. a. m.

A heavy earthquake. The shock lasted upwards of seven seconds. The vibrations were from north to south. Some glassware in some of the hotels in and around town was broken (V?, VI?).

1893. June 30; Petaluma; 5:30 a. m.

A slight shock. The vibration was from north to south and was of short duration.

1893. June 30; Niles; 5:30 a. m.

N. to S., duration 10 sec.

1893. June 26-30.

The San Francisco *Call* of July 7 contains a story of terrible earthquake shocks and other calamities experienced on San Nicolas Island (one of the Santa Barbara group, off San Diego, some 70 miles) as brought by the captain of the steamer *Jennie Griffin*, but further investigation renders it very doubtful whether any great disturbance occurred.

1893. July 1; Lakeport.

A shock.

1893. July 12; Albuquerque, N. Mex.

Three shocks of earthquake that shook, from west to east, every house in the city and vicinity and every movable article were distinctly felt here this morning between 6 and 7 o'clock. The chandeliers in the Commercial Club, a stone structure, rocked for at least ten minutes, and the early risers at the club became very much agitated (VI?). A number of clocks throughout the city stopped (VI?). The wave came from the west.

1893. July 12 and 22.

Shocks at Arcata and Hydesville, Cal.

1893. July 21; Napa City.

A shock.

1893. July 22; Cape Mendocino Lighthouse; 1:20 n. m.

Light shock. (Ms. communicated by U. S. Geological Survey.)

1893. July 24; Tomales (Marion Co., Cal.).

A shock.

1893. July 30; San Francisco; 1h. 30m. a. m.

A short, sharp shock. The motion was from the southwest.

1893. July 30; Oakland; 1h. 30m. a. m.

Two light shocks, with scarcely a second elapsing between them.
No damage.

1893. August 5; Mount Hamilton; 9h. 16m. p. m.

A very light shock started the clock (only) of the Ewing seismograph at 9.16 p. m. and registered on the duplex as a very simple tracing of only one or two vibrations nearly east and west, the maximum amplitude of the tracing being 2.5 mm. It was not felt by any one at the Lick Observatory.

1893. August 9; San Francisco; 1h. 15m. a. m.

A sharp earthquake shock. Messages from Santa Rosa and Sacramento state that it was quite severe in those places. So far as known no damage was done. 1h. 12m. a. m. Sharp shock. Duration 8s.—T. T.

1893. August 9; San Diego.

Two slight shocks were noticed by the local observer of the weather bureau to-day, one at 11.02 a. m., the other at 4.07 p. m.

1893. August 9; Alameda.

Quite a sharp shock was felt at 1.15 a. m., Mr. Perrine's duplex seismograph giving a tracing 5 mm. in a northwest and southeast direction, and at right angles to this 1.5 mm.; also felt at Berkeley.

1893. August 9; Petaluma.

A lively shock of earthquake was felt in this city at 1.10 this morning, followed for some time afterwards by tremors. In all, six shocks were felt, the first being the heaviest. It was the most severe felt here for years. The vibrations were north to south, and lasted fifteen seconds. No damage is reported, but several clocks stopped, plaster cracked, and crockery was thrown from the shelves. Many people were badly frightened (VII).

1893. August 9; Santa Rosa.

The severest earthquake felt here since 1868 occurred this morning at 1.12 o'clock. The oscillations were apparently southeast and northwest. Considerable damage was done in the way of falling chimneys, broken windows, etc. The court-house was badly shaken up, and the plastering extensively damaged (VII?, VIII??).

1893. August 9; Sonoma.

The residents of this valley were awakened at 1 o'clock this morning by a heavy shock of earthquake (VI?, VII?). 1.15 a. m. at Napa; 1.13 a. m. at Petaluma.

1893. August 9; San Rafael.

This morning at 1.10 o'clock, two severe earthquake shocks were felt. The vibrations were from east to west. The second shock was the heaviest.

1893. August 9; Healdsburg; 1h. 10m. a. m.

A sharp shock, or rather three continuous shocks. The sky, which was clear, was in a few minutes overcast with fog clouds—something not witnessed here for several weeks, although usual in summer.

1893. August 9; San Francisco.

Yesterday morning the Catholic churches of this city celebrated the feast of St. Emigdius. High mass was celebrated in the principal places of worship in honor of the day, with the especial object of obtaining the protection of St. Emigdius and his prayers to Almighty God, asking for his protection against the calamity of earthquakes, for he is patron against such disastrous visitations.

This observance with high mass was introduced by Archbishop Alemany after the alarming earthquake which visited this city in 1868, and has been celebrated in most of the Catholic churches in the United States since that time, and received the sanction of the Pope.

1893. August 12; Mills College.

Prof. Josiah Keep sends a tracing of a slight but quite sharp disturbance recorded on his seismograph at 12.50 p. m. The record shows a displacement of the pen amounting to 5 mm.

1893. August 12; Alameda.

A very slight shock was felt about 12 m. Mr. Perrine's duplex seismograph gives a tracing of but a single vibration.

1893. August 14; Toutle River, Washington.

Mr. Fred G. Plummer reports: "Earthquake at 5.07 a. m., N. 40° W.—11 miles from summit of Mount St. Helens. One sharp shock *vertical*. Intensity IV. Distinct rumbling preceding for four seconds, near at hand toward the mountain." At Green River Mines, Washington, IV, lateral, rumblings.—P.

1893. August 16; Austin (Nev.); 12:30 a. m.

Two shocks.

1893. August 27; Cape Mendocino Lighthouse; 9h. 34½m. p. m.

Clock pendulum nearly stopped (VI), but was again started by the observer.

1893. August 30; Candelaria (Nev.); 10 a. m.

Duration 3 sec., N. W. to S. E.

1893. September 1; Santa Cruz Lighthouse; 11:16 p. m.

Waked sleepers, etc. (VI). In the town of Santa Cruz, 2 miles distant, the shock is described as unusually heavy; vibrations there were N. to S. (Ms. communicated by U. S. Geological Survey.)

1893. September 1; Gilroy.

A sharp shock of earthquake occurred to-night at 11.20 o'clock. It was of several seconds' duration. Niles 11.17 p. m.

1893. September 2; San José.

Mr. Colton reports that he felt a slight shock of earthquake shortly after 10 p. m., exact time not noted, while in his room at the St. James Hotel.

1893. September 5; Carson City; 11 p. m.**1893. September 6; Redding.**

Quite a severe shock of earthquake was felt here at 8.22 o'clock this morning, preceded by rumbling. It lasted several seconds and the vibration was north and south. No damage.

1893. September 7; Las Lunas (N. Mex.).

Central New Mexico has been subject almost daily for more than three months to violent earthquakes. Five commotions Thursday, September 7, threw down a score of old adobe buildings already shaky from previous earthquakes (VII). No lives were lost, but a peculiar feature is that there were numerous cases of nervous sickness, even convulsions, among the inhabitants as soon as the rumbling commenced. The center of the disturbance is Sabinal, where a spring has appeared in a place which always had been dry and barren.

1893. September 28; Mount Hamilton.

Prof. Holden reports the time as 6.20 a. m. Intensity (II), Rossi-Forel scale. Mr. Colton was awakened by the shock and reports "one slight shock," the time being 6.20.10 a. m., Pacific slope time. The Duplex seismograph shows a slight mark of disturbance.

1893. October 15; Santa Cruz; 5 a. m.

A severe shock. The undulations were from west to east.

1893. October 19; Napa (Cal.); 4:20 p. m.

Cal. S. W. Service Bulletin.

1893. November 7; Guadalajara, Mexico.

A severe earthquake has occurred here during the past ten days. The Colima volcano is in violent eruption, and people living at the base of the mountain have left their homes.

At the town of Americus the first severe shock did great damage to property, and several persons were wounded by falling houses (VIII). The disturbance was felt in the States of Oaxaca, Puebla, Guerrero, Morelos, and Jalisco.

1893. November 6; Alaska.

There have been four earthquakes during the summer at St. Augustine Island (Chorna Borna), where the mountain is now emitting dense clouds of smoke. The natives, remembering the devastation caused by the eruption twelve years ago, are deserting the island in haste, abandoning all their interests. The last eruption rendered useless all existing charts of the neighboring waters, causing no fewer than five shipwrecks.

1893. November 21; Capistrano; 7h. 48m. p. m.

A slight shock, which lasted only about two seconds. From the motion of the swinging lamps, the vibrations must have been from west to east.

1893. December 5; Piedras Blancas Lighthouse (S. Luis Obispo Co., Cal.); 8:56 p. m.

Very light shock, lasting about 2 seconds. (Ms. communicated by U. S. Geological Survey.)

1893. December 6; Lewer's Ranch (Nev.); 6 p. m.

Lewer's Ranch (Nev.), 6 p. m.—C. W. F.

1893. December 6; Victoria, B. C.

An active volcano on the American side of the straits was one of the scenes witnessed by the passengers on the steamer Maud, which returned from Alberni to Victoria, B. C., yesterday.

1893. December 11; Carson City; 3:10 p. m.

E. and W. tremor.—C. W. F.

1893. December 12; Lakeport; 3 a. m.

Quite a severe earthquake. The vibration was from west to east. No damage.

1893. December 12; Ukiah; 3h. 15m. a. m.

A sharp shock. The clocks in the public buildings were stopped. Vibrations were from south to north (VI).

1893. December 17; Ontario; 10h. 50m. p. m.

Quite a sharp shock.

1893. December 17; Riverside; 10h. 40m. p. m.

A slight shock. The vibrations, which lasted only a few seconds, were from south to north. No damage.

EARTHQUAKES ON THE PACIFIC COAST, 1894.

1894. January 7; Point Arena Lighthouse; 9:45 p. m.

(IV.)—(Ms. communicated by the U. S. Geological Survey.)

1894. January 14; Olympia, Wash.

Mr. Fred. G. Plummer reports a disturbance at 3.25 a. m. A tremor lasting three seconds was followed after an interval of four seconds by a shock from south-southwest, and a slight tremor later. His seismograph at Tacoma barely showed the shock (I?, II?).

1894. January 14; Vancouver (B. C.).

While the quaking continued, hanging pictures swayed slightly and crockery rattled on the shelves.—*S. F. Chronicle*.

1894. January 17.

[Reports were published that on January 17 Mount Jefferson, as seen from Salem, Oregon, poured forth smoke and steam from its summit at sunrise. Later explanations showed this to be due to atmospheric phenomena.]

1894. January 24; Riverside; 3h. 50m. a. m.

Quite a heavy shock, which lasted several seconds.—*San José Mercury*.

1894. February 5; Keeler, Cal.

A shock of earthquake was felt at 9.01 p. m.—Newspaper.

1894. February 7; San Jose.

At 2.09 o'clock a. m. there was a slight shock in this city. One short, sharp shock.—*San José Mercury*.

1894. February 8; Los Angeles; 5h. 45m. a. m.

The earthquake shock felt here at 5.45 this morning was also felt quite generally in this section. It was short and sharp, and there was only one shock.—*S. F. Examiner*.

1894. February 15; Hawthorne, Nev.; 9:01 p. m.

(II.)—Report of Nevada State Weather Service, 1894.

1894. March 3; Mount Hamilton.

One shock of intensity III, R. F. 4h. 42m. 50.1s. p. m.—E. S. Holden.

Rattled stoves, etc., slightly in second and third stories of brick dwellings. 4h. 43m. 1s. p. m.—Mr. and Mrs. W. W. Campbell. Neither of the seismographs showed any record of this shock.

1894. April 15; 20h. 56m.

Ellensburg, Washington, III, duration 10s.—P.

1894. May 7; Mount Hamilton.

Two distinct shocks, two seconds apart, of equal intensity. 11h. 56m. 7s. p. m. for the last shock.—E. E. Barnard.

Four shocks in less than 2 seconds, of intensities III, II, II, III, R. F., respectively. 11h. 56m. 16s. ± 10s. p. m. In bed in the third story of the brick dwelling.—W. W. Campbell. No record of this disturbance was found on either of the seismographs.

1894. Mount Hamilton.

At 10h. 52m. p. m. a movement of the earth was detected by the meridian circle, which was so slight as not to be felt by the observer. The motion was a regular oscillation in an east and west direction, and lasted for fifteen to twenty seconds. At 11h. 56m. 45s. approximately, one single sharp shock was felt.—R. H. Tucker.

1894. May 23; Tacoma, Washington; 22h. 30m.

II.—P.

1894. May 27; Winchester, Cal.; 12 a. m.

Two slight shocks.

1894. June 3; Ukiah (Cal.).

A shock.

1894. June 18; 10 a. m.

Austin, Nevada.—C. W. Friend.

1894. July 13; Pine Ridge, Cal.

News comes from Pine Ridge lumber district, 60 miles northeast of this city, to the effect that a sharp shock, lasting a few seconds, was felt there at 8.50 last night. The shock was accompanied by the greatest electric display ever witnessed by inhabitants there. The strange feature is that no clouds were noticed by the citizens.—*S. F. Call*.

Parties arriving from Pine Ridge, 50 miles east of here, state that a recent earthquake [July 13?] injured the dam across Stephen-son Creek. The joints in the masonry were damaged sufficiently to allow the water to pass through, but it is believed that no permanent injury was done.—*S. F. Chronicle*.

1894. July 14; near Fresno.

A remarkable phenomenon is reported from the Sierra Nevada Mountains east of Fresno. About sunset last evening a red cloud, apparently fifty miles in length, gradually settled over the range, and as soon as night came on persons in this city observed a wonderful display of electricity on the edges of the cloud.

To-day news from that region says that when the electrical display was at its height an earthquake, violent enough to rattle

houses and shake trees, was felt (VI). It continued several seconds. After it had subsided the cloud rapidly passed away and the atmosphere became clear.

So far as can be learned the earthquake was felt at no place else than immediately under the cloud. It was not felt on the plains, 20 miles distant.—*S. F. Chronicle*.

1894. July 18; Ogden, Utah.

At 3.50 p. m. distinct earthquake shocks were felt. Dishes were shaken from the tables, the walls of some large blocks were cracked, and a general shaking up occurred (VIII?). Many people were frightened into leaving their houses.—*S. F. Chronicle*.

1894. July 29; San Bernardino.

A shock of earthquake occurred at about 9.15 p. m. The movement was of several seconds' duration, and seemed to be from the northwest to the southeast. The disturbance was very noticeable, causing doors and windows to rattle, chandeliers to swing, and buildings to vibrate (VI). No one was injured and no property destroyed.

The First Methodist Episcopal Church was occupied at the time the earthquake occurred. The building is large and built of brick, and the disturbance caused a panic that was soon quelled, though a number sought safety in the open air (VI). The pastor continued his discourse as soon as quiet was restored.

In the yard at the depot cars standing on the track were put in motion and the men had to set the brakes.

Some report seeing a large meteor at the same time the shock occurred. The clock in the old court-house tower stopped at 9.21 p. m. (VI?).—Newspaper report.

1894. July 29; Arlington (Cal.); 9 p. m.

Two shocks, the first light, the second severe.

Los Angeles: at 9.12 p. m. the city was shaken by an earthquake, which was one of the most severe felt for many years. The undulations appeared to be from south to north, and there were three distinct tremors. The first was a light one, but the second made the windows rattle and disturbed loose articles lying about on mantels and shelves (VII?). With the third tremor the wave passed. As far as could be learned no damage was done, aside from the breaking of a few panes of glass (VI?). The shocks created consternation in some of the hotels, and caused the inmates to start out in more or less confusion. The tower of the City Hall swayed very perceptibly, and the electric-light masts continued to vibrate for fifteen or twenty minutes after the disturbance.

In the stores along Spring and Main streets the chandeliers swung like clock pendulums and the glassware and crockery

rattled at a lively rate. In some places the guests rushed out, leaving their meals uneaten, but soon recovered from the scare and returned. At the post-office, in the Federal Building, which is one of the most solidly constructed edifices in the city, the shock was very severe, and caused a panic. The only damage done, however, was the breaking of several bottles of ink, which were jarred off the shelves (VI?).

Pasadena: a severe shock was felt here at 9.17 p. m., lasting ten seconds. The motion was from northwest to southeast, and the shock was accompanied by a loud rumbling. It was felt all over the city, brick buildings being shaken until the bricks creaked. There was much excitement in the churches and meetings. No damage was done in the city so far as known. At Echo Mountain the new hotel was shaken.

Santa Monica: two distinct shocks were felt about 9.11 p. m., the last shock being the heaviest ever felt here. The plate-glass windows in the Hotel Jackson were distinctly seen to wave in and out. No damage (V?, VI?).

Santa Ana: at 9.15 o'clock this evening this city was visited by the heaviest earthquake ever experienced here. Buildings shook and glassware and crockery rattled (V?, VI?). There were three shocks, the vibration being from south to north. The electric-light masts continued to vibrate for some minutes after the shock.

Mojave: a heavy shock of earthquake at 9.12 o'clock this evening shook this town badly. Goods were knocked off the counters of stores and general excitement prevailed. The vibration was from north to south (VII?).

Ontario, Cal.: the severest earthquake shock ever felt here occurred at 9.12 p. m. No damage.—*Los Angeles Times*. This shock felt at Chino (9.15 p. m., "sharp shock"); Fallbrook (9 p. m., "slight," S. W. to N. E.); Tremontville (9 p. m., three shocks); Ventura 9.15 p. m.).

1894. August 3; Mount Hamilton.

Professor Holden reports a single shock of intensity III to IV on the Rossi-Forel scale as awakening him at 11h. 50m. p. m. \pm one-half minute. He was expecting an alarm clock to go off, and presumably was easily awakened. The duplex seismograph gave a record of this shock, the displacement of the earth being 0.25 mm. in an east and west direction.

1894. August 3; Hydesville; 9:30 p. m.

"Slight."—Cal. S. W. Service *Bulletin*.

1894. August 22; Lewers Ranch, Nevada; 4:28 a. m.

II.—Report of Nevada State Weather Service, 1894.

1894. September 30; Mount Hamilton.

The record of a single vibration was found on the duplex seismograph on the morning of October 1. The seismographs were examined on the evening of September 30 and again on the morning of October 1, when the record was noticed, so that the shock must have occurred in this interval, although it was not felt by any one here and did not start the Ewing instrument. The displacement of the earth was about 0.25 mm.

Eureka: Two heavy earthquake shocks occurred here this morning, the first at 9.36 o'clock, lasting nearly half a minute. The vibrations were from north to south. The second was at 9.59 o'clock, the vibrations being from northeast to southeast. It lasted five seconds. No damage.

Sisson: A slight earthquake shock was felt in this vicinity this morning. The vibrations were from north to south.—*S. F. Chronicle.*

Hydesville: 9.37 a. m., quite heavy, 10.22 a. m., very light.

1894. September 30; Edmonton (Cal.); 9:30 a. m.

A slight shock.

1894. October 17; Pasadena; 3:05 p. m. local time.

A severe triple shock.

1894. October 23; San Diego (6:03 p. m.?).

Two very heavy shocks. Clocks stopped, etc. (VI). A third shock at 7.25 p. m. Very light.

1894. October 23; San Diego.

This city and neighboring towns were visited this afternoon by a series of earthquakes of more than ordinary severity. The first shock occurred at (3.03 p. m.?) and was followed at intervals of a quarter of a minute by two others, the last being one of the strongest experienced hereabouts since the advent of Americans. People in brick houses swarmed into the streets, hearing the grinding of brick and mortar and seeing in some cases the walls crack (VII?, VIII?). A loud noise was heard in all parts of the city immediately preceding the shock. Considerable consternation was caused in the public schools.

The second shock was observed by few people, being very light, but the third was so pronounced as to bring the people into the streets without delay (VII?). Messages from Coronado, Upper Otay Dam, Campo, National City and other places show that the earthquake was felt about equally at all surrounding points. Loose rocks were shaken from the hillsides and rattled down the canyons, and a heavy booming noise accompanied the tremors. The weather observer reported another slight shock at about 4.25 o'clock, not so strong as the first ones, but quite perceptible. It

was not felt on the ground. The waves were from east to west in all instances. No serious damage was done.

Riverside: two distinct shocks of earthquake occurred at 3 p. m. The first was light, followed in a few seconds by quite a sharp shake. No damage.

San Bernardino: two distinct shocks were felt here at 2.04 p. m. The vibrations lasted twenty seconds and the motion was from west to east.

Colton: a light shock was distinctly felt here about 3 p. m.—*S. F. Examiner*.

Los Angeles: a slight shock was felt here at 3.05.—*San José Mercury*.

1894. October 27; Los Angeles.

A slight shock occurred here to-night at about 11 o'clock. No damage.

San Diego: a shock of 10 seconds' duration was felt here at 11.05 to-night. It caused some excitement, but no damage is reported.—*S. F. Chronicle*.

1894. November 2; Mexico City.

Two violent earthquake shocks occurred at 4.17 p. m., with four minutes' intermission. During the vibrations the earth seemed rocking like a ship at sea and the natives were on their knees in the streets praying frantically.—*S. F. Bulletin*.

1894. October 23; Julian (Cal.).

A sharp shock, 3 p. m.

1894. October 24; Berkeley (Cal.).

Slight record.—Professor Soule.

1894. October 24; Claremont (Cal.).

Two shocks, 3h. 4m. 40s. p. m.

1894. November 10; Carson (Nev.); 6:55 p. m.

E. W., light.—C. W. F.

1894. November 14; Gold Hill, Nev.; 2h. 2m. (p. m.?).

An earthquake. There were two shocks, with an interval of a minute between them. Most of the people thought the disturbances were caused by blasts in the mines. At 6.58 o'clock this evening a shock occurred that brought the occupants of many buildings into the streets (VII). It was of short duration, but rattled windows and glassware at a lively rate. The vibrations appeared to be from southeast to northwest.—*S. F. Chronicle*.

Carson, Nev.: 6.55 a. m. (I).

Lewers Ranch, Nevada: 7.05 p. m. (I).—Report of Nevada State Weather Service, 1894.

1894. November 14-18; Nevada.

The following table was sent to the U. S. Weather Bureau by F. A. Carpenter, observer at Carson City. The times are all 75th meridian times. [I have added the last column.—E. S. H.]

Date.	CARSON CITY.		VIRGINIA CITY.		Difference in Time.
	Time.	Direction.	Time.	Direction.	
Nov. 14	9.55 A. M.	.....	.....	.....	.....
" 16	2.07 A. M.	.....	2.00 A. M.	.....	+ 7 m.
" 16	2.25 A. M.	E. & W.	2.18 A. M.	E. & W.	+ 7 m.
" 16	3.00 A. M.	E. & W.	2.52 A. M.	.....	+ 8 m.
" 18	5.38 A. M.	.....	5.28 A. M.	.....	+ 10 m.
" 18	5.40 A. M.	.....	5.30 A. M.	.....	+ 10 m.
" 18	5.49 A. M.	E. & W. (light)	5.40 A. M.	N. & S. (severe)*	+ 9 m.
" 18	8.15 A. M.	.....	8.00 A. M.	.....	+ 15 m.
" 18	8.33 A. M.	.....	8.24 A. M.	.....	+ 9 m.
" 18	9.22 A. M.	.....	9.18 A. M.	.....	+ 4 m.

* Walls cracked; window glass broken (VII).

1894. November 15; Carson, Nev.

Three heavy earthquake shocks were felt here. The first and heaviest was at 11.05 p. m., the second at 11.25 p. m., and the third at 12. The direction was east and west. Though the shocks caused fright, no damage was done.—*S. F. Chronicle*. [11.07 p. m., 11.25 p. m., 12.00 p. m., all "light."—C. W. F.]

Gold Hill, Nev.: three tremors of intensity II. (No time given.)
Lewers Ranch: at midnight three tremors of intensity III; felt by persons all over Washoe Valley.

Virginia, Nev.: 11 a. m. (II); 11.18 p. m. (II); 11.52 p. m. (II).—Report of Nevada State Weather Service, 1894.

1894. November 16-22; Virginia, Nev.

There have been, according to different calculations, over one hundred shocks of earthquake in this city within the week. The greater number of vibrations have come from west to east. Nevada has been almost free from earthquakes since the advent of the white man. There are no Indian traditions in reference to former earthquakes in any portion of Nevada as far as can be ascertained from the most intelligent of the Indian residents here.—*S. F. Examiner*.

1894. November 17; Campo; 5h. (p. m.?).

A heavy shock lasting several seconds. The oscillation seemed to be from northeast to southwest.—*S. F. Chronicle*.

1894. November 18; Carson, Nev.

Earthquake shocks continue to be felt. Between 3 and 7 o'clock this morning six distinct shocks were felt, the first being very heavy. Thus far no damage has been done except to cause acute nausea (VII) and prevent sleep. The direction of the vibrations

varies considerably, and the shocks are usually preceded by a roaring sound.—*S. F. Chronicle*. [2.38 a. m.; 2.40 a. m.; 2.49 a. m. (III, sharp); 5.15 a. m.; 5.33 a. m.; 7.22 a. m.; all "tremors" except 2.49 a. m.—C. W. F.]

Austin, Nev.: 10 a. m. (II); Carson, 2.38 a. m. (I); 2.40 a. m. (I); 2.49 a. m. (III); 5.15 a. m. (I); 5.33 a. m. (I); 6.22 a. m. (I).

Gold Hill, Nev.: four tremors of intensity II. (No time given.)

Lewers Ranch, Nevada: (no time given.) (I.)

Virginia, Nev.: 2.28 a. m. (II); 2.30 a. m. (I); 2.40 a. m. (IV) (this shock cracked plastering; in some places walls were damaged; in many instances window glass was broken (VI?, VII?)); 5 a. m. (II); 5.24 a. m. (I); 6.18 a. m. (II).—Report of Nevada State Weather Service, 1894.

1894. November 19; Julian (Cal.); 10:20 a. m.

A shock, followed by lighter ones for several days.

1894. November 21; Mount Rainier (Tacoma).

F. L. Lowe, a carpenter, says he and some companions were within 6 miles of Mount Tacoma's top, November 21, and that several shocks of earthquake were distinctly felt at the mountain's base. Several great avalanches were heard crashing down the mountain side on the north of the mountain. Rocks were piled over 100 feet high in the Puyallup River. Returning they crossed the débris of an avalanche which was of great depth, half a mile wide and 4 or 5 miles long.—*San José Mercury*.

1894. November 21; Tacoma, Wash.; 6h. 30m. p. m.

Several slight shocks. Windows were rattled throughout the city. The first shock was most severe, being accompanied by rumbling noises, as of a distant explosion, and simultaneously a sheet of flame was observed in the eastern heavens.

Carson, Nev., in night (I).—Report of Nevada State Weather Service, 1894.

1894. Mount Rainier, Washington.

Mount Rainier, Washington; much has been said in the newspapers concerning an appearance of change in the summit of this mountain. The principal facts seem to indicate some sort of change, possibly due to avalanches, and the report that smoke issued from the crater seems worthy of credence. On the morning of November 21 five citizens of Seattle report that they saw puffs of smoke coming from the west side of the top of the mountain at intervals of twenty seconds from 6.20 to 8 a. m. The smoke came up in huge, balloon-shaped masses, and after hanging suspended for a short time was wafted toward the eastern side of the mountain. Before 8 o'clock the top of the mountain had lost its whiteness, and appeared dark, jagged and rough. The same phenomena were observed from Tacoma and Portland. On the

afternoon of Thursday, December 13, smoke was seen rising from the crater by Observer Saulsbury, of the Weather Bureau, and others, from Seattle. Mr. Saulsbury saw the phenomenon through a glass repeatedly from 9 a. m. to 1 p. m., and was positive that the substance was smoke and not vapor.

The Seattle *Post-Intelligencer* sent out an exploring party in the latter part of December to reach the summit if possible and determine the character of the phenomena. This party, owing to the dangerous condition of the snow fields, could get no farther than the foot of Carbon Glacier, from where the following message was sent back by homing pigeon on December 26:

"The expedition has been an entire success. It has demonstrated that while the mountain has been smoking and steaming, the change is due principally to tremendous avalanches and not to an eruption. The new peak observed from Seattle is off Columbus crest, and was formed by spiral winds carrying snow and whipping it into the cone-shaped peak described."—*San José Mercury*.

The Seattle *Post-Intelligencer* of January 6, 1895, contains a full report of the expedition. Without being able to reach the summit, the explorers report having seen, on December 24, jets of steam issuing from the large crater and a column of black smoke from the small crater.

Of interest in this connection is the following report from Ellensburg:

"The eruption of Mount Rainier has explained a mystery that has baffled all. The waterworks reservoir here suddenly became exhausted. Investigation showed a crevice running along the hill north and south, varying from 1 inch to 1 foot in width and of unknown depth. It ran directly through the reservoir, letting the water out. It has been traced several hundred feet along the hill. No shocks of earthquake have been felt here as far as known."—*S. F. Chronicle*.

(Ellensburg is over 200 miles distant from Mount Rainier.—C. D. P.)

1894. November 24; Carson, Nev.; 10:03 p. m. (II); 11:22 p. m. (III).
(Sharp.)—Report of Nevada State Weather Service, 1894.

1894. December 4; Carson, Nev.; 9:39 p. m. (I); Lewers Ranch; 9:40 p. m. (II).

Report of Nevada State Weather Service, 1894.

1894. December 18; Carson, Nev.; 9:09 p. m. (II).
(C. W. F.)—Report of Nevada State Weather Service, 1894.

1894. December 21; Gold Hill, Nev.; 2:20 a. m. (II).

Report of Nevada State Weather Service, 1894.

1894. December 23; Los Angeles.

Earthquake shocks were experienced this morning at San Diego, Riverside, Pomona and other points. No damage was done.—*San José Mercury.*

1894. December 24; Boise, Idaho.

Boise was visited by three slight earthquake shocks this morning. The first was very slight, about 4 o'clock; the second light, about 6 o'clock. The third shock was felt everywhere in the city, and came at 7.10 o'clock. Houses vibrated perceptibly and people were awokened (VI). The shock was accompanied by a booming sound like the roar of a gale of wind.—*S. F. Chronicle.*

1894. December 28; Gold Hill, Nev.; 9:15 a. m. (I).

Report of Nevada State Weather Service, 1894.

1894. December 29; Gold Hill, Nev.; 4:30 a. m. (II). 5 p. m. (I).

Report of Nevada State Weather Service, 1894.

1894. December 30; City of Mexico.

At 10.53 o'clock on Sunday (December 30), an oscillatory earthquake shock was felt in this city and other parts of the valley of Mexico. The movement was east and north, but of short duration. The disturbance caused great alarm among those who feared a repetition of the disastrous earthquakes of November 2, which killed 18 people and did great property damage. In the Arben Theater, the only playhouse now open in this capital as a result of the damage sustained by other theaters in previous shocks, a stampede occurred (VII?).

The scene of November 2 was repeated in a large part, and thousands of penitents knelt in the open streets and prayed and cried in a loud voice for deliverance from death.

Large supply pipes leading to the city burst, flooding the streets. The shock last night lasted nine seconds. It is known that three persons were seriously injured. A number of buildings were destroyed (VIII?).—*S. F. Call*, January 2, 1895.

EARTHQUAKES ON THE PACIFIC COAST, 1895.¹**1895. January 5; Mount Hamilton; 3h. 4m. 57s. ± a. m.**

One light shock.—A. L. C. The duplex seismograph registered a disturbance principally northeast and southwest (one wave), the displacement of the earth being 0.5 mm. There was a series of vibrations at right angles to this of about $\frac{1}{4}$ mm.

¹ This list contains several occurrences the correctness of which may well be doubted. These cases rest upon newspaper report entirely and are of such a nature that there should be confirmatory evidence before accepting them. It has been thought best to include these doubtful cases, however, and they are indicated by some note after them.

1895. January 7; Lewer's Ranch (Nev.); 11 a. m.
—C. W. F.

1895. January 15; Gold Hill; 6 a. m.
—C. W. F.

1895. January 23; Ukiah.

A heavy shock of earthquake was felt in this city this morning. After the shock the sky cleared and the rain ceased.—*San José Mercury*, January 23, 1895.

1895. January 25; Lewer's Ranch (Nev.); 4 a. m.
—C. W. F.

1895. January 26; Helena, Mont.

An earthquake shock was felt here at 5 o'clock this morning. Small articles were shaken off the shelves.—Newspaper report.

1895. February 25; Portland, Oreg.; 4:47 a. m., standard time.

Three slight shocks from northward. Intensity III.

Tacoma, Wash., and points to the southward: same time. Three slight shocks from S. 10° W., intensity III; Green River Mines, intensity V. My "home-made" seismograph only records horizontal shocks and showed only $\frac{1}{10}$ inch. The directions noted would place center near Toutle River, where I observed a vertical shock—already reported (1893).—F. G. Plummer, Tacoma, Wash.

Portland, Oreg.: three distinct shocks of earthquake were felt here early this morning. Each shock lasted about three seconds. The first occurred at 4:47. The vibrations were from north to south.—*San José Mercury*, February 26, 1895.

Tacoma, Wash.: this morning's earthquake shock was plainly felt in Tacoma, on top of the hill, and at Edison, at Sumner, Puyallup, and Steilacoom. There were three light vibrations occurring just before 5 o'clock, the general trend being from north to south, though at Steilacoom the vibrations seemed to be from east to west.—*San José Mercury*, February 26, 1895.

1895. February 28; Independence (Cal.); 12:25 a. m., 120th meridian time.

Duration 20 sec. The shock was preceded by unusual noise. A second shock about 2 minutes after the first. Light objects overturned, tables moved, etc. (VII). The shock was felt from Bishop's Creek to Keeler.

1895. March 1; Ayatlan, Mexico.

Inhabitants of Southwestern Mexico are alarmed over the frequent earthquake shocks which have occurred during the last month, although little damage has been done. Shocks are accompanied

by subterranean rumblings, followed by a discharge as from an artillery, which shakes the earth for nearly half a minute at a time. The recent outbreak of the subocean volcano off the Pacific coast, in Guerrero, is ascribed as the reason for the frightful demonstrations.—*S. F. Examiner*, March 2, 1895.

1895. March 1; at sea, off the Mendocino (Cal.) coast; longitude 125° 20', latitude 40°.

The recent earthquake which was reported as having disturbed the inhabitants of Mendocino proved to be a veritable terror at sea, according to the stories told by the crews of the schooners Volant and C. T. Hill, which have just arrived from that section of the coast.

The Volant was about 52 miles off the Mendocino coast, in the vicinity of Shelter Cove, when she encountered the shake-up. It took place a few minutes before 1 o'clock on the morning of March 1. The sea had been quite calm all night, but the breeze kept up well. The first warning of the earthquake came in the form of a deafening roar which seemed to rise out of the sea. In an instant the ocean was lashed into a mass of foam, and in spots it rose in great geyser-like columns. The schooner stopped with a crash and then shook for fully two minutes. Every timber and bolt groaned and creaked, and it was thought for a moment that she was going down. Those on deck were knocked down. The schooner pounded up and down frightfully for a few minutes, just as if she were aground, and then all became still. We had scarcely recovered our senses when a second shock came, but it was not nearly so severe as the first. When this one was over the sea became as still as a mill pond, the wind died out, and everything was as quiet as death. The schooner C. T. Hill, which was carrying lumber, was also tossed about by the tremor. She was only a few miles astern of the Volant at the time. Captain Forest's story of the experience is similar to that told by the crew of the Volant.—*S. F. Chronicle*.

NOTE.—Inquiries addressed to the captains of the vessels named, through the Merchants' Exchange of San Francisco, elicited no reply.—C. D. P.

The following paragraph by Dr. Edward S. Holden, from the *Publications of the Astronomical Society of the Pacific*, Vol. VII, 1895, page 131, is of interest:

"The *S. F. Chronicle* of March 8, 1895, gives an account of a severe earthquake shock experienced by two vessels some 50 miles off Cape Mendocino, in longitude 125° 20', latitude 40° (both approximate). My List of Recorded Earthquakes in California (1887) contains several notices of shocks felt in this vicinity, as follows:

- " " At sea, 45 miles W. S. W. of Cape Mendocino;
- " " At sea, 50 miles W. S. W. from Cape Mendocino;
- " " At sea, longitude 126° 25', latitude 41° 55';

"At sea, longitude $125^{\circ} 50'$, latitude $40^{\circ} 24'$;

"At sea, longitude $125^{\circ} 20'$, latitude 40° —(as above)."

"A relief map of the ocean bed near Cape Mendocino, made by Prof. George Davidson and Mr. Winston, shows the coast to be very 'steep-to'; and it further shows two submarine mountains in the neighborhood.¹ The slipping of the earth at the junction of the steep submarine cliff with the (comparatively) flat ocean floor may very well be the cause of some of these disturbances. It is also possible, at least, that they are connected with the two submarine elevations mentioned. More observations are needed to decide this question. It is a little remarkable that we have reports of shocks felt at sea in this vicinity and none, or few, at other points along the coast." (See Oct. 24, 1895.)

1895. March 10; San Miguel Island.

This is one of a chain of islands about 30 miles off the coast, near Santa Barbara, Cal. On March 17 newspapers published reports of a disturbance on this island about March 8, by which the shore in places was elevated 60 feet and other considerable changes wrought. Another disturbance is reported about March 30, by which a small schooner was wrecked in the harbor at the island. A third disturbance was reported in July on Flea Island, an islet in the immediate neighborhood. Through the kindness of Mr. J. J. Hollister, of Santa Barbara, we learn that there was a large landslide on San Miguel Island. This fact was worked up by a newspaper reporter into a very sensational article.

Cordoba, Mexico: the peak of Orizaba is reported in press dispatches to be in a state of eruption after many centuries of quiescence.

1895. March 12; Mount Hamilton; 9h. 34m. 17s. p. m., Pacific standard time.

One short, sharp, vertical shock. Rossi-Forel (V).—E. S. H. At 9h. 34m. 17s. p. m., Pacific standard time (in sitting room on Mt. Ptolemy), strong vertical shock, followed by two very quick weak shocks. All three lasted less than 1s. Absolutely no horizontal component noted. Intensity of first shock IV or V.—W. W. C. 9h. 34m. 17s. p. m., Pacific standard. One sharp shock followed by one or two slight tremors. Doors and other objects rattled in third story of brick dwelling. Rossi-Forel V.—C. D. P. The duplex seismograph recorded several small vibrations without any decided tendency as to direction; the displacement of the earth being about $\frac{1}{8}$ mm.

1895. April 1; Eureka; Sh. 42m. a. m.

A sharp shock. The vibrations were from southwest to northeast. —Newspaper report.

¹ This map is reproduced in the present volume.

1895. April 6; San José.

The *Evening News* reported a shock "just before 7 a. m." The correspondent of the *S. F. Chronicle* reported a shock about 6.45 a. m. Not felt at Lick Observatory.

1895. April 16; Port Townsend, Wash.

Two slight shocks were felt here shortly after midnight last night. Heavy brick buildings trembled and many people were frightened badly.—*S. F. Examiner*, April 17, 1895 (VI?).

1895. April 17; Vacaville.

Quite a sharp earthquake shock was felt here this morning about 12.30 o'clock.

Virginia, Nev.: there was a short, sharp shock at 6 o'clock this evening.—*S. F. Chronicle*, April 18, 1895.

1895. April 18; Ukiah.

A small unnamed island off the coast of this county (Mendocino), opposite Bournes Landing, is now in a state of eruption, according to the report of an observer. For some time past it has been reported that flames were issuing from the center of the isle. J. E. Meredith, who has been traveling along the northern coast for some weeks, passed the island Thursday. It was some time during the early evening, and he was attracted by a bright light in the west. The flames were so brilliant that he at first imagined they were caused by a burning ship at sea. On his return south the next day, however, he discovered smoke curling up and then saw it emanated from a peak on the island.—*San José Mercury*, April 22, 1895.

NOTE.—This has not been verified.—C. D. P. Forest fire?—E. S. H.

1895. April 19; Victoria, B. C.

A slight shock of earthquake, moving from east to west, was felt here a little before midnight. Buildings all through the city trembled and all the telephone calls came down together with a clatter.—Newspaper report.

1895. April 27; City of Mexico, Mexico.

Colima volcano is again in a state of eruption, emitting great columns of smoke and fire both night and day. The inhabitants of the immediate neighborhood of the volcano are leaving their homes.—Newspaper report.

1895. May 1; Lakeport; 2h. 30m. a. m.

Quite a severe shock. The vibrations were from west to east and lasted from five to seven seconds. No damage.

1895. Ukiah; 3h. a. m.

A severe shock, lasted some seconds.—Newspaper report.

1895. May 21; San José-Mount Hamilton.

[The telephone operator in San José reported a shock of earthquake in San José about 10.45 a. m. W. W. C. and R. H. T. (at Mount Hamilton) noticed *rattling* about that time, but felt nothing. The duplex instrument shows a slight mark, probably from this shock, of 1 mm. (earth's movement $\frac{1}{4}$ mm).—N. W. Later it was learned that the nitroglycerin works at Pinole, Contra Costa County, had exploded at 10.40 on that morning. Doubtless the shock noted above was due to this explosion. Pinole is nearly 60 miles in an air line from Mount Hamilton.]

1895. May 24; Berkeley.

Slight record.—Professor Soulé.

1895. June 4; Berkeley.

Slight record.—Professor Soulé.

1895. June 4; San Francisco.

[A blast of 15,000 pounds of powder was exploded on Clarendon Heights. No effect was noticed at Mount Hamilton.]

1895. June 10; Berkeley.

Slight record.—Professor Soulé.

1895. June 11.

[A newspaper account from New Whatcom, Wash., says Mount Baker (40 miles away) has been smoking or steaming, and that a new peak has appeared between the dome and south peak, visible at New Whatcom with the naked eye. Note.—This report has not been verified.—C. D. P.]

1895. June 15; Port Townsend, Wash., June 16.

[Chimacum, a small farming center 4 miles from here, was terribly shaken last night at 8 o'clock by the falling of a huge meteor, which burst with a loud noise, and after causing a small-sized cyclone of several minutes' duration, buried itself deep in the muddy bottom of a neighboring lagoon. The meteor struck with force enough to break crockery in farmhouses 3 miles away and created great terror among the residents. Ten hours after the occurrence the waters of the lagoon were still bubbling and seething, and were found to be hot. Systematic dragging of the lagoon failed to bring up any traces of the celestial messenger.—*S. F. Examiner*, June 17, 1895.]

1895. June 20; Mount Hamilton; 9h. 43m. 26s. p. m. Pacific standard time.

"One shock of intensity II or III, northeast and southwest, third-story brick house."—C. D. P. The duplex instrument shows a single displacement of the earth of about $\frac{1}{2}$ mm. in a northeast and southwest direction with several very small vibrations at the end.

"About forty-five minutes after the first earthquake shock a star viewed in the 12-inch equatorial was seen to vibrate sharply over an arc of 1" or 2". The telescope was clamped at the time. If this was a second earthquake shock it was too slight to be felt."

—R. G. A.

Smith Creek: a lady visitor reported that the earthquake of June 20 was felt at Smith Creek, foot of Mt. Hamilton.

1895. June 16; Cocopah Mountains.

George Neal, a mining man, saw a sight on the desert last Sunday that filled him with amazement. He was in company with Lew Hosgate at the time. Their property is on the Tajo River. At that place the desert is in plain view for miles. Neal looked across toward the Cocopah Mountains, and was surprised to see a heavy column of smoke ascending from the central peak of the three Pichacos that rose several hundred feet. Neal and Hosgate watched the black column, and saw it shoot high into the air at intervals, and a distant booming sound was heard as of cannonading. The Indians told them that the Cocopah country was on one of its "tantrums" again, and that the mud volcanoes, gas fissures, hot springs and fire volcanoes were all at work with more activity than ever before. Many Cocopah and Santa Catalina Indians were reported to have fled from the mountains into the interior of the peninsula and over to the Colorado River. Gas wells or fissures exist, according to the Indians, which blow at irregular intervals, emitting a whistle which can be heard for miles.—Newspaper report. Note.—This has not been verified.—C. D. P.

1895. June 24; Mount Hamilton; 9h. 25m. 36s. \pm 2s., standard Pacific time.

"One earthquake shock at the above time. I was observing with the 36-inch. Planet moved north and south over about 5" or 6"."—E. E. B.

"A slight earthquake shock was noticed at 9h. 25m. 41s., Pacific standard. The 12-inch equatorial telescope was directed at ν Scorpii at the time, and stars A and B were seen to vibrate three or four times over an arc of nearly 4" north and south in the field of view, coming back nearly to their original position."—R. G. A. The duplex seismograph shows a single displacement of the earth of about $\frac{1}{6}$ mm. about north-northeast and south-southwest.

1895. June 28; Seattle; Wash.

Assistant Weather Observer E. O. Hobbs has recently been making some examinations on the summit of Mount Rainier with a small telescope and has discovered a large dark crevasse through the center of Columbia Crest, which can be seen plainly with the naked eye. A large snowslide has recently occurred at the base

of Liberty Cap on the north side, and on the west side there appear to be several new crevasses of various sizes. Mr. Hobbs has also noticed the mountain steaming and smoking in the same manner as last winter.—*S. F. Chronicle*, June 29. Note.—This report has not been confirmed.—C. D. P.

1895. July; Nanaimo, B. C., via Vancouver, B. C., July 9.

The earthquake shock at Nanaimo this week caused no little alarm in that city. The alarm was, however, soon dissipated, and the shock, which lasted a few seconds only, did no damage except the breakage of some crockery in houses and stores (VII). There are persistent reports by dwellers in the neighborhood of Hope, a small town about 100 miles up the Fraser River, to the effect that one of the small mountains in the Smimilkameen is an active volcano. Flames are seen shooting therefrom at night, and several parties have lately attempted, in consequence, to explore the vicinity.—Newspaper report.

1895. July 26; Santa Barbara; 4:10 p. m.

Earthquake lasted three seconds. Vibration northwest to southeast.—*S. F. Chronicle*, July 27.

1895. August 4; Gilroy; 2 a. m.

A shock. The vibration was from west to east, and lasted but a second. No damage.—*S. F. Call*.

1895. August 15-17; Virginia, Nev.

Six shocks, two of which were quite severe, during the past two days.—Newspaper report.

1895. September 1; Tacoma, Wash.

The mountain-climbers who returned to-night from Mount Tacoma report steam, smoke and gas belching from the foot of Nisqually Glacier, where the Nisqually River has its source.

At the rim of the crater, southeast of Columbia Crest, the ground is quite warm, notwithstanding the arctic atmosphere of the summit. Steam comes out of the crater at this particular point more freely than any other part.—*San José Mercury*, September 2, 1895.

1895. October 7; Mills College; 7:17 p. m.

"With this I send a blue print of an earthquake tracing, the first I have observed for some time. The shock occurred about 7h. 17m. p. m., October 7, 1895, and was distinctly felt, though it was not severe. There was a slight premonitory rumbling, then a distinct shaking."—Josiah Keep. The tracing inclosed with the above is somewhat indistinct, and the limits of vibration consequently uncertain, but seems to be about 10 mm. by $1\frac{1}{2}$ mm., the longer direction being about north-northwest by south-southeast. The disturbance seemed to be composed of several nearly parallel waves.

Albuquerque, N. Mex.: the people of Sabinal and Jorales, two small settlements south of this city, are greatly excited over three distinct earthquake shocks, and many have moved from their homes into the mountains. The waves were from the southeast to the northwest and were so strong that houses rocked to and fro and household goods tumbled from the shelves (VII?). The shocks were felt here last night, but only slightly.—*S. F. Examiner*, October 8, 1895.

1895. October 14.

The tide-gauge of the U. S. Coast Survey at Sausalito shows evidences of a heavy storm or earthquake. The irregularities in the record began at 8.20 a. m. on October 14 and lasted continuously for eighteen hours.—*S. F. Call*, October 19, 1895.

1895. October 20; Olympic Mountains, Washington.

[This range was reported in active eruption about this time, but upon investigation it was found that the flames seen were those of forest fires and from a burning vein of lignite coal.]

1895. October 24; at sea, off the California coast.

The ship John C. Potter, Captain Meyer, makes the following report to the Merchants' Exchange:

"October 24, in latitude 43° 54' north and longitude 128° 32' west, experienced a severe shock of earthquake, lasting 25 seconds. It made the ship shake as if it had jumped over a coral reef in a heavy swell."—*S. F. Chronicle*, October 31, 1895.

1895. November 7; Mount Hamilton; 5h. 46m. 34s. a. m.

"Slight shock. 3h. 12m. 55s. p. m., two severe vibrations a second or two apart; direction of motion seemed to be *downward* and toward the northeast."—A. L. C.

"3h. 12m. 51½s. p. m., Pacific standard time. In southeast corner room, first story, brick house. Heavy shock lasting four or five seconds; R. F. (V). One or two light trembles and then two heavy waves, the principal direction *felt* being about southwest and northeast. Motion appeared to be almost entirely horizontal; could not distinguish any decided vertical motion. Some article in the dark room fell to the floor after the heaviest shocks. Disturbance ended rather abruptly. Wind light, from northeast. Hazy. No noise noticed before the shock. A small notch in barograph record at this time. Barometer unsteady, but this notch seems as if it might be due to the earthquake." Notch is 0.01 or 0.02 of an inch in depth.—C. D. P. The Ewing instrument was not started, but the pens show a vibration as follows:

East and west,	4.0 mm. = 1.2 mm. displacement of earth,
North and south,	3.7 mm. = 1.1 mm. displacement of earth,
Vertical movement,	10.5 mm. = 6.6 mm. displacement of earth,

which, however, is very uncertain and is undoubtedly very much augmented by the "creep" of this pen due to temperature, which is large. The clock was started, giving the time as 3h. 12.7m. p. m.

The duplex seismograph shows a complicated series of motions, of which the greatest were east-southeast and west-northwest 7 mm., or $1\frac{3}{4}$ mm. actual displacement of the earth. The greatest displacement of the earth at right angles to this direction was $\frac{3}{4}$ mm.

San José: the city was visited by a sharp shock of earthquake at 3.14 o'clock this afternoon, lasting ten seconds, the vibrations apparently being from east to west.—*S. F. Examiner*, November 8, 1895.

Santa Cruz: an earthquake, the heaviest in five years, was felt here at 3.15 o'clock this afternoon. The vibrations were from east to west.—*S. F. Examiner*, November 8, 1895.

San José: San José was visited by an earthquake about 3.15 o'clock yesterday afternoon. There were two sharp shocks of short duration. No damage.—*San José Mercury*, November 8, 1895.

1895. November 26; Mount Hamilton.

"A light shock was felt to-day at 1h. 56m. 35s., Pacific standard time. Its direction could not be noted. (II? E. S. H.) Its duration was but momentary. I should estimate its intensity on the Rossi-Forel scale as III."—R. G. A.

1h. 56m. 35s. p. m., Pacific standard. Light shock. Rossi-Forel II.—C. D. P. Did not start the Ewing instrument. The east-and-west pen shows a vibration of the earth of about 0.5 mm., and the north-and-south pen a vibration of about 0.4 mm. The vertical motion is masked entirely by the "creep" due to temperature. The duplex instrument shows one (only) complete wave, about northeast and southwest, with a displacement of the earth of 0.4 mm.

1895. November; Kyuquot, B. C.

Via Victoria, British Columbia, November 30. Kyuquot, an Indian village on the west coast of Vancouver Island, received a severe shock of earthquake early this month which the natives will long remember. Their little houses were shaken almost from their foundations, trees swayed, and considerable damage was done (VI).—*S. F. Call*, December 1, 1895.

1895. December 8; Fairfield.

A few minutes before 8 o'clock this morning a heavy shock of earthquake was experienced here, lasting five seconds. Three distinct oscillations were plainly felt, the vibrations running from northeast to southwest.—*S. F. Chronicle*, December 9, 1895.

Fullerton: a heavy shock, closely followed by a lighter one, was felt here early this morning.—*S. F. Chronicle*, December 9, 1895.

Napa: a distinct shock was experienced, lasting several seconds.—
—*S. F. Call*, December 10, 1895.

1895. December 12; Ukiah; 12h. 40m. a. m.

A slight shock. The oscillations were from east to west.—*S. F. Call*, December 13, 1895.

1895. December 23; Santa Barbara; about 9h. 30m. p. m.

An earthquake was felt which lasted several seconds.—Newspaper report.

1895. December 28; Mount Hamilton.

9h. 12m. 13s. a. m., Pacific standard.—R. G. A. 9h. 12m. 01s. a. m., Pacific standard, by seismograph clock. Recorded on both seismographs. The Ewing instrument shows a disturbance lasting about ten seconds in each horizontal component, and about six seconds in the vertical.

North and south.—The waves of shortest period and greatest amplitude occurred in this component, beginning within one second of the starting of the plate. The vibrations are of short period, but smooth and regular. The largest one measured had a double amplitude (magnified) of about $\frac{1}{8}$ mm. and a period of one-fourth second, which according to the formula gives an intensity of 32 mm. per second and would be between I and II of the Rossi-Forel scale. The main portion of the disturbance lasted about five seconds, some tremors for ten seconds.

East and west.—The first few vibrations are of short period, followed by slower vibrations of about two seconds. The greatest amplitude (double and magnified) is about $\frac{1}{4}$ mm.

Vertical.—Two waves of about two and one-half seconds each and a double amplitude of about $\frac{1}{4}$ mm. (magnified).

The waves are all too small to measure with any great accuracy.

EARTHQUAKES ON THE PACIFIC COAST, 1896.¹

1896. January 3; Esquimalt, B. C.; 10:09 p. m., P. s. t.

“A distinct shock of earthquake.”—Reported by E. Baynes Reed, Esq.

1896. January 3; Victoria, B. C.

A severe shock of earthquake was felt here to-night at 10.20 o'clock. Many citizens in the public offices, believing the shock to be produced by the falling in of some large roof, or like cause, hurried to the streets.—Newspaper report.

¹ Included in this list are one or two cases, the correctness of which may be doubted. These cases rest upon newspaper evidence entirely and are of such a nature that there should be confirmatory evidence before accepting them. It has been thought best to include these doubtful cases, however, and they are indicated by some note.

Port Angeles (Wash.): at 10.30 o'clock last night two distinct shocks of earthquake were felt in this city. They were severe enough to shake the chimneys off lamps and the dishes off the shelves (VII).—Newspaper report dated January 4, 1896.

1896. January 8; 9:56 p. m.; Turn Point L. H., Washington.

A shock.—Ms. kindly communicated by the U. S. L. H. Board.

1896. January 5; Cocopah Mountains, via Indio, January 5.

Prospectors report seeing immense quantities of smoke and steam rising off the desert toward the volcanoes below the Cocopah mountains during the day and a bright light at night, showing that the volcanoes in that vicinity are again in active operation.
—*S. F. Chronicle.*

1896. January 8; Lake Chapala, Mexico, via San Diego (Cal.), January 12.

Professor E. H. Coffey of this city has just received a letter from a correspondent living near Lake Chapala, State of Jalisco, Mexico, which describes some startling phenomena occurring there. Lake Chapala is a sheet of water fifty miles long and ten miles wide. The formation of the country around it is purely volcanic. On the forenoon of January 8th the residents of one of the small settlements near the western end of the lake were terrified to see a gigantic whirlpool raging far out on the waters. The water rose in great serpentine movements and from all directions rushed towards a common center, where a vast cavity seemed to exist. At the same time a heavy rumbling, apparently in the bowels of the earth, took place. The whirlpool was caused by the sudden sinking of a large portion of the lake's bottom. The disturbance continued for twenty minutes, and before it subsided several pleasure boats were drawn into the whirlpool and disappeared with their occupants. It is estimated that a score of lives were lost.—*S. F. Examiner*, Jan. 13.

1896. January 25; Carson, Nevada.

Professor C. W. Friend reports: "We have had quite a number of earthquake shocks on January 25th and 27th, 1896; they were rather peculiar. On the 25th the first noticeable one occurred at 4.45 a. m., and was the heaviest that day. I also noticed one at 4.46 a. m. and 5.02 a. m., both light. The motion W. to E. was hardly perceptible.

We had quite a number of shocks on the 27th:

7.59 a. m. S. to N. (II),
8.34 a. m. W. to E. (III),
11.04 a. m. S. W. to N. E. (III),
11.19 a. m. S. W. to N. E. (I),
1.01 p. m. S. W. to N. E. (IV),
6.32 p. m. S. W. to N. E. (II),

and quite a number of very light tremors between, which I noticed, being quiet in the building. The seismographs did not record a spot larger than one-tenth inch on the plate for all of these, although some of the shocks were quite severe, so much so that it scared a great many people. On the 25th I hung up a one-ounce plumb bob on a fine thread three feet long in a glass case fastened to a stone wall, and it was all I could do to determine the motion by it; all the shocks, including those of the 25th, were vertical and produce a very strange feeling."

1896. January 27; Carson, Nev.

The first heavy shock was about 8.30 o'clock in the morning, and it was quick and lively. It rattled the glass and china in everybody's cupboard, made the windows shake and got several lazy people out of bed (V?). The next was about 11 o'clock and was also quite sharp. At 1 o'clock came the heaviest of all, and it shook every building in the city. The Capitol building was particularly well shaken, and inside of a minute there was a rush to the basement of the building to see the record of the seismograph. It had been deflected about an eighth of an inch by each shock and had also recorded small shocks all through the day.

The Signal Service records showed a very unsettled barometer. Rapid changes occurred and their suddenness was unequaled by anything recorded since last July. These shocks were all graded as No. III, Rossi-Forel scale. There were two others during the day that graded I and II respectively. The first was north and south, the second east and west and the last three southwest and northeast. They were principally vertical.

The jar at 1 o'clock made a large crack in the side of the Government building and shook some of the plaster from the ceiling of the county building (VII).—*S. F. Call.*

1896. February; Tauquiz Peak, via Los Angeles, February 4.

A special to the *Times* from San Jacinto says: There is considerable excitement here over what appears to be an eruption of part of the San Jacinto mountains called Tauquiz Peak, twenty miles from here. The streets of San Jacinto have been crowded with people looking through telescopes at the ominous clouds of smoke which have hung over Tauquiz all day. When first noticed at 9 o'clock the vicinity of the peak was hazy with smoke. Within the next hour this cleared away and glasses leveled at the extinct volcano were able to detect a straight line of smoke ascending. Soon this disappeared and then puff, puff, came more black smoke, like that which pours out of the smokestack of a locomotive.

The smoke has continued to pour out of Tauquiz all day, and everybody is much excited, fearing an eruption. This peak has been

pronounced by scientists an extinct volcano.—*S. F. Chronicle*, February 5, 1896.

This report has not been confirmed.—C. D. P.

1896. February 5; Tauquiz Mountain, via San Bernardino, February 5.

Parties who have returned from the San Jacinto Mountain report that Mount Tauquiz gives out mysterious rumblings and that smoke is plainly visible. To-day smoke was seen from this city.—*S. F. Chronicle*.

1896. February 5; Tauquiz Mountain, via San Bernardino, February 7.

Mount Tauquiz, a spur of the San Jacinto Mountains, and well known to be an extinct volcano, situated about twelve miles from the town of San Jacinto, is again reported to be giving forth smoke. Two men from San Jacinto say a column of vapor can be plainly seen rising from the highest point and that it looks nearly as white as snow. Reports of this mountain being in a state of active eruption have been numerous for several days, and to-morrow a party of newspaper reporters will leave the city on an expedition to Tauquiz. The last four miles of the trip will have to be made through banks of snow several feet in depth, the mountain being covered with snow this season of the year and being 10,000 feet in height.—*S. F. Examiner*, February 8, 1896.

1896. February 5; Tauquiz Mountain, via San Bernardino, February 9.

It is reported to-day that people in and about Mount Tauquiz are getting ready to leave the vicinity, as the action of the mountain, to say the least, is very threatening.

The first that was noticeable in its strange demeanor was a whistling sound—not shrill, but hoarse and guttural-like. This was followed by a deep roar like distant thunder, followed by peal on peal.

This continued for several days, when one morning the Indians in camp were startled by a shock like that of a heavy earthquake and immediately smoke was seen issuing from the mountain's peak, at first in thin white layers, followed immediately by puffs like from the smokestack of an engine. This has kept up almost incessantly up to date.

It has been handed down in Indian history in that neighborhood that Mount Tauquiz once belched forth volumes of fire.—*S. F. Call*, February 10, 1896.

1896. February 6; East Clallam (Wash.); 9h. 55m. p. m.

Quite a well-defined shock. The direction of the tembior was from west to east. It lasted about a minute. Every house in the town, large and small, was shaken to its very foundations, but as far as can be learned no damage was done.

The Indians on Neah Bay reservation all felt the shock. The same shock was also experienced on Tatoosh Island about the same time. The captain of the bark Edinburghshire, lying at anchor in the bay, says the shock was felt by every person aboard his vessel. Some of the sailors became so scared that they wanted to take to the ship's boats.—*S. F. Chronicle*.

1896. February 13; Redding.

A slight earthquake shock was felt in this city about 10 o'clock this forenoon. The shock was more perceptible in the western part of the city and on the hill upon which the county court-house stands.

Weaverville: three successive shocks of earthquake were felt very perceptibly here at five minutes to 10. They were of short duration with a vibration from south to north. Buildings of more than one story received a hard shaking.

Eureka: at 9.55 o'clock this morning a sharp shock of earthquake, vibrating from north to south, was felt in Humboldt county.—*S. F. Examiner*, February 14, 1896.

1896. February 15; Los Angeles.

A distinct shock of earthquake was felt here at 2.52 p. m. The tremor lasted several seconds. Large buildings of substantial structure were considerably shaken. In the court-house the shock was distinctly felt by the county officials and their deputies, and they were frightened.

Pasadena: Pasadena was visited by a slight earthquake shock at 2.57 o'clock this afternoon, lasting about fifteen seconds. The wave seemed to pass from northwest to southeast.—*S. F. Call*.

1896. February 15; Los Angeles.

A slight shock, lasting about two seconds, was felt in this vicinity at 2.45 o'clock this afternoon.—*S. F. Chronicle*.

1896. March 15; Burrard Mountains, B. C., via Vancouver (B. C.), March 16.

One of the Burrard mountains, directly opposite Vancouver and ten miles distant, is believed to have been in a state of eruption last night. Numbers of persons vouch for the accuracy of the statement. C. Harris, a reputable lawyer, declares that dense smoke and flames poured from the mountain for several minutes. No one has scaled the mountain, so that its geological formation is not known. In view of the fact that several shocks of earthquake occurred here in the past year, the story is believed by many.—Newspaper report.

This report has not been confirmed.—C. D. P.

1896. March 19; 4:01 a. m.

Carson (Nev.), light.—C. W. F.

1896. March 20; 11:25 p. m.
Carson (Nev.), light.—C. W. F.

1896. April 2; Portland (Oregon).
About 3.20 a. m. a single shock of brief duration was felt here. The shock was felt as far south as Salem.
McMinnville (Or.): the inhabitants were awakened at 3.17 this morning by an earthquake (VI). Two or three distinct shocks followed in quick succession, with a loud rumbling noise coming from the west. The earth appeared to tip toward the east.—*S. F. Chronicle*.

1896. April 28; San Francisco; 2h. 57m. p. m.
A slight shock, lasting a very short time. It was observed by none of the weather bureau officials on the tenth floor of the Mills building.

“We were in the office of the Alaska Commercial Company at 310 Sansome Street when the shock occurred,” said Professor Davidson. “All who felt the shock agreed that the movement was from east to west. The shock was very light and of short duration, lasting not more than a second, if that long. My son took the time, which was 2.57 p. m.”—*S. F. Chronicle*, April 29, 1896.

1896. April 28; Alameda.
A disturbance was registered by Mr. Perrine’s instrument, the principal motion being north and south.

1896. June 5; 10:20 p. m.; Cape Blanco Lighthouse (Oregon).
“Tower vibrated considerably for about 30 seconds. I could not say positively that it was caused by an earthquake.”—Mss. kindly communicated by the U. S. L. H. Board.

1896. June —; Big River (Cal.) via Ukiah, June 23.
Considerable excitement was created on the coast of Mendocino “a few days ago” by an immense tidal wave. The swell was seven feet higher than ordinary and rushed up Big River with great force. The great wall of water is attributed to the Japanese earthquake.—*S. F. Chronicle*, June 24, 1896.

1896. July 3; San Diego; 9h. 27m. p. m.
A severe shock of earthquake. It lasted for several seconds. The oscillation was from north to south and was quite pronounced.—Newspaper report.

1896. July 13; Berkeley.
Slight record.—Professor Soulé.

1896. July 23; Vallejo; 1h. 50m. a. m.
A sharp shock. The vibrations were from southeast to northwest.—*S. F. Chronicle*.

1896. July 25; Berkeley.

Slight record N. and S. [?].—Professor Soulé.

1896. July 26.

Same as July 25 [?].

1896. August 11; Mount Hamilton; Sh. 58m. 7s. \pm p. m.

P. s. t. Rossi-Forel (II).—E. S. Holden.

No record of the above on either of the seismographs.

1896. August 11; Alameda.

Mr. Perrine's seismograph shows quite a complicated tracing, the principal disturbance being east and west.

1896. August 17; Merced.

At 3.40 o'clock this morning Merced was visited by an earthquake which lasted about three seconds. The roll was from north to south and shook things up quite lively for the time. Many clocks stopped as a result (VI).

Visalia: a slight earthquake shock was felt here early this morning; a very slight tremor followed in about five seconds by three distinct wave-like motions in quick succession. The direction the waves traveled seemed to be a little north of west. The time, as fixed by different observers, was from 3.29 to 3.30 o'clock.—*S. F. Chronicle*.

Visalia: at 3.26 o'clock this morning Visalia was shaken by an earthquake. There were two distinct shocks. Many persons were awakened and alarmed (VI).—*S. J. Mercury*, August 18, 1896.

1896. August 18; Mount Hamilton.

11h. 0m. 24s. \pm p. m. P. s. t. Rossi-Forel III.—E. S. Holden. 11h. 0m. 13s. p. m. P. s. t.—A. L. Colton.

Napa: a slight shock was felt here this afternoon.—*S. F. Chronicle*.

1896. August 18; Evergreen, Santa Clara Co.; 11h. 00m. 15s. p. m., P. s. t.

I was awakened by a slight earthquake running apparently from north to south.—Wm. Wehner.

1896. August 19; Alameda.

A slight disturbance was recorded by Mr. Perrine's seismograph. The direction of motion could not be determined.

1896. August 26; Mount Hood, Oregon.

Newspaper dispatches report the narrow escape of a party of tourists on Mount Hood on the afternoon of August 26 from an avalanche. The dispatches convey the impression of a volcanic eruption, but it seems entirely possible to explain the occurrence without any such assumption. A slight earthquake may have accompanied, or even caused, the avalanche. No reports have been received of any disturbances elsewhere on that day.

1896. September 1; Pinole, Contra Costa County.

[At 1 o'clock p. m. the works of the California Powder Company exploded. There were three separate explosions, the heaviest one being the mixing-house with its 15,000 pounds of dynamite. This explosion was not noticed at Mount Hamilton, nor did the seismographs or barometers record any tremors.]

1896. September 10; Santa Rosa; 3h. 45m. a. m.

A sharp shock. The vibration was north and south.—*S. F. Chronicle*.

1896. September 24; Mount Hamilton.

5h. 25m. 30s. ± p. m. P. s. t. R. F. (III).—E. S. Holden.

5h. 25m. 45s. p. m. P. s. t. R. F. (I). L. O. main building creaked, but did not notice any particular motion. There was a slight mark on the plate of the duplex seismograph.—C. D. P.

1896. September 30; Descanso.

—Cal. S. W. Service *Bulletin*.

1896. October 19; Santa Rosa; about 6 a. m.

Quite a severe earthquake shock. The vibrations were from north to south, lasting about three seconds. No damage.—*S. F. Chronicle*.

1896. November 3; Mount Hamilton.

10h. 58m. 44s. ± 1s. a. m. In my office rattled stove, lamp-shade, etc. Three or four short, sharp shocks, all within 1½ second.—W. W. Campbell.

1896. November 11; Cahto.

Two shocks of more than ordinary note were felt here at 2 o'clock this morning. They shook crockery from shelving, stopped clocks, etc., doing no material damage. The vibrations were from east to west and the duration was about four seconds (VI).—*S. F. Chronicle*.

1896. November 29; Mount Hamilton.

11h. 3m. 37s. a. m. P. s. t. An irregular, slight shaking lasting 5s. or 6s. Not exactly like the vibrations of an earthquake, but could find no other explanation, R. F. (I). I was in the 12-inch dome at the time. No record on the seismographs.—C. D. P.

1896. December 8; Mexico.

A heavy earthquake occurred to-day at the various Pacific ports of this republic, the first shock coming at 9.30 a. m. and the second, an up and down and very alarming one, at 1.30 p. m., and at 5 p. m. the third shock occurred. No casualties are reported.—*S. F. Chronicle*, Dec. 9, 1896.

1896. December 17; Santa Barbara.

"A tidal wave, the largest in the history of Santa Barbara, washed over the boulevard at 8 o'clock this morning, carrying back with

it a large section of that beautiful and expensive driveway. The boulevard was built some five years ago and bulkheaded so securely that it was thought to be impervious to the action of the waves, but the bounding billows carried off a portion of asphaltum and solid masonry, heavy framework and iron in its receding grasp, nearly fifty feet square and eight feet deep. A large sand hill between the boulevard and ordinary high tide was carried completely out to sea."—*S. J. Mercury*, Dec. 18, 1896.

1896. December 22; Mount Hamilton.

- 1h. 52m. 41s. P. s. t. R. F. (V).—E. S. H.
1h. 52m. 43s. P. s. t. (middle of shock). 3s. duration. Did not rattle dishes.—W. W. C.
1h. 52m. 44s. P. s. t. (end of shock).—W. J. H.
1h. 52m. 44s. P. s. t. (end of shock), duration estimated at 2s.—A. L. C.
1h. 52m. 37s. \pm 1s. P. s. t. Time noted at cottage.—R. G. A.
1h. 52m. 40s. p. m. P. s. t. (beginning). Second floor brick house. Lasted 2s.-3s. Light tremors increasing to two well-marked vibrations, then dies out suddenly. Building creaks. Direction seemed to be N. and S.—C. D. P.
The duplex seismograph recorded a small disturbance, about N. W. and S. E.—1.5 mm. \times 1 mm. N. E. and S. W. The clock only of the Ewing instrument was started.

1896. December 31.

The following notes are from MSS. kindly communicated by the U. S. Lighthouse Board. The reporters are the lighthouse keepers:

- Coquille River (near Bandon), Oregon: the station went into operation Feb. 29, 1896. No earthquakes during the year.
Cape Arago, Oregon: no record of earthquakes from January 4, 1891. No previous record.
Umpqua River, Oregon: station went into operation January 1, 1895. No record of any earthquakes.
Haceta Head, Oregon: station went into operation April 1, 1895. No record of any earthquakes.
Cape Meares, Oregon: station went into operation January 1, 1890. No record of any earthquakes.
Tillamook Rock, Oregon; also Point Adams, Oregon; no record of any earthquakes.
Cape Disappointment, Washington; also Willapa Bay, Ediz Hook, New Dungeness, West Point (all in Washington), have no records of any shocks on their books. Narrowstone Point, Washington, went into operation April 7, 1896. No earthquakes recorded.
Patos Island, Washington, went into operation December 1, 1893. No earthquakes recorded.

